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CAMERON BLOWOUT PREVENTERS

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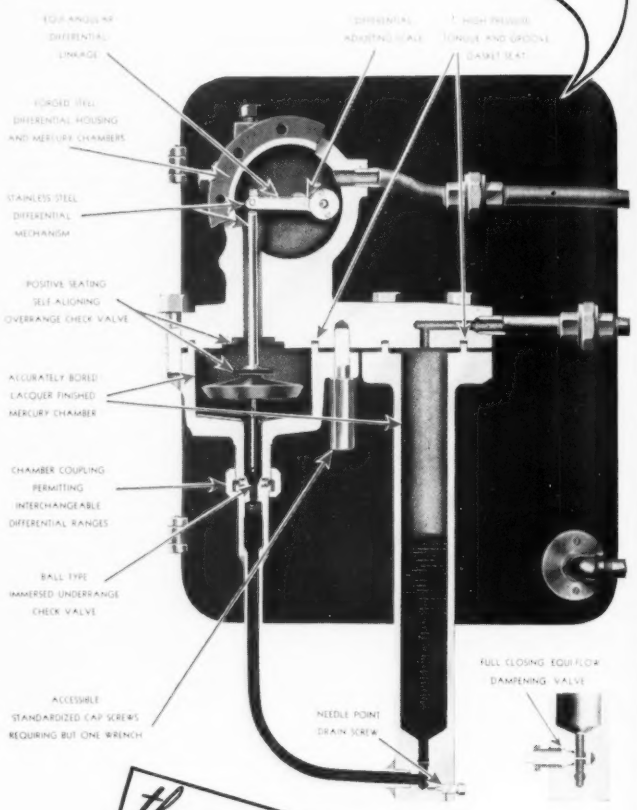
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the OIL AND GAS JOURNAL

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Table of Contents

NEWS DEVELOPMENTS

Speakers at A. P. I. Meeting View Industry's Prospects as Brightest Ever 154
Public-Relations Survey Reveals Three Issues 156
Two Pipe-Line Projects Announced; Magnolia Plans New Line 157
Geologists Hear of Oil Potentialities on Continental Shelf 158
France Projects Large Expansion of Country's Refining Capacity 162
S.A.E. Engineers Point Way to Postwar Automotive Progress 164
Gasoline Market Manifests Slightly Firmer Trend 168
Refiners Looking at "Tricks of Trade" in Solving Postwar Problems 349
Greater Profit Seen for Distillate Fuels 349

Editorial 153
This Week 157
International News 160
Watching Washington 166
Refining News 324
Pipe-Line News 327
Natural-Gas News 331
Statistics and Trends 332

A. P. I. SECTION

Report on the A. P. I. Public-Opinion Survey:
- Those Who Know You Well Think Well of You 170
- What Does the Public Think About the Petroleum Industry? 172
- Appreciation of the Industry 176
- Awareness of the Industry 178
- Some Highlights of the Analysis 179

Naphtha Polyforming 180
Naphtha Polyforming With Outside Gas 188
Gas-Condensate Reservoirs—A Review 189
Reservoir Performance and Well Spacing, Silica Arbuckle Pool, Kansas 201
Aviation Fuel Properties Varied by Alkylate-Hydropolymer Content 215
Correlation of Operating Variables in the Polyform Process 225
Corrosion and Preventive Methods in the Katy Field 235
Analysis of Alkylates and Hydrocodimers 236
Relationship of Free Enterprise to Modern Traffic Facilities 239
Recent Developments in Pipe-Line Technology 241
Use of Corrosion Inhibitors in Products Pipe Lines 255
Practical Aspects of Directional Drilling 263
A. P. I. Symposium on Secondary Recovery:
- Separators and Tanks 281
- Flowing Water-Flood Production 284
- Pumping-Equipment Selection for Secondary Recovery 287
- Use of Plugging Agents 289
- Five Years of Operating at Langlie Unitized Project 295
- Distribution Systems and Surface-Injection Equipment 300
- Utilization of Old Wells 304
- Source and Purification of Gas Supply 306

ENGINEERING AND OPERATING

Oil Production by Water—Part 3 of a Series 314
Questions on Technology 317
Operating Ideas 318
The Refiner's Notebook 321
Engineering Fundamentals 323

EXPLORATION AND DRILLING

Daily Well-Completion Record 332
Daily Average Production for Week 333
Exploration and Proven Reserves 335
Reports by Areas Start on Page 335

ADDITIONAL FEATURES

Market Summary 332
Crude-Oil Prices 332
Calendar of Events 348
Drilling Contractors 350
Personals 352
Equipment Men in News 354
Classified Advertising 356
Advertisers' Index 360

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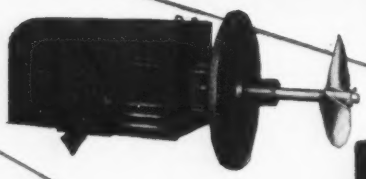

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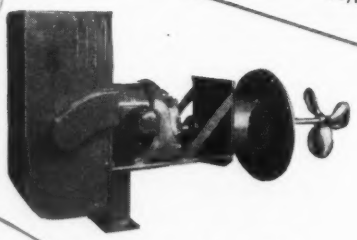

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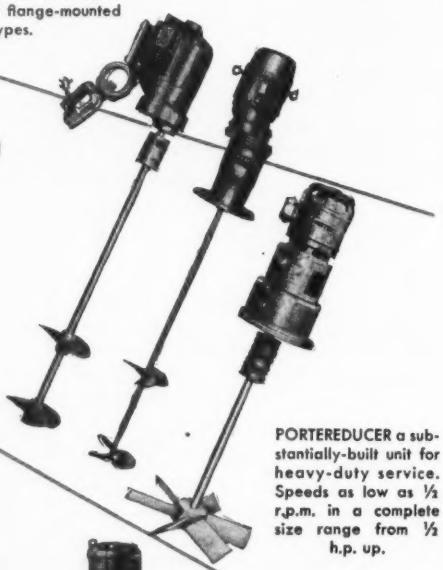

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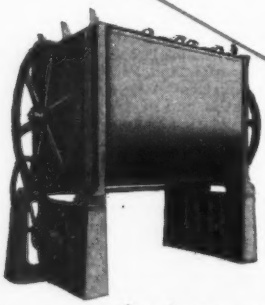

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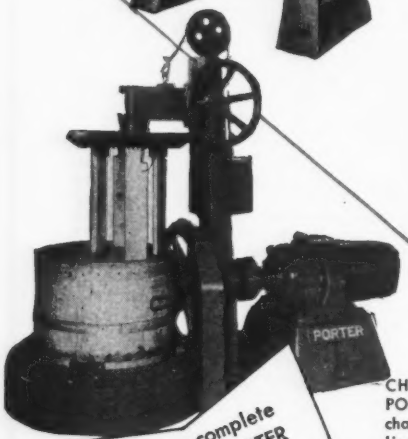

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THE OIL AND GAS JOURNAL

Public Relations

PUBLIC relations as an oil-industry activity in the past has been much like Mark Twain's weather—everybody talks about it but no one does anything about it. Every oil man who is alert to the views of others knows that the petroleum industry does not have the public-opinion rating to which it is entitled. Largely because of that fact, operators have often been called to Washington by departments of Government to explain industrial conditions—unwarranted actions which would not have materialized if the public had the facts about their business.

It was both timely and fitting for the membership of the American Petroleum Institute in their annual-meeting sessions this week, at the start of what many observers insist is a "new era" for petroleum and all business, to give thought as to what must be done to bring about a better understanding of the oil industry by 140 million people, most of whom are its customers.

The report of Opinion Research Corp. at the Chicago meeting was conclusive as to its findings and reveals the facts as to strength and weakness of the oil industry's present position. The frankness in the presentation of the details of the findings is to be commended.

One fact stands out in the research report and that is that tens of millions of consumers have no complaints in regard to the service they are getting nor with the prices they pay for petroleum products. Thus the oil industry has already established the base on which a sound public-relations platform can be built. There is no need to gloss over the operating facts of this industry in any phase of its activities.

The A.P.I.-sponsored survey reveals that the unfavorable aspects of the public's attitude spring from a lack of information. The industry rates highest in the oil country where it is best known. There people have a better appreciation of the extent of its activities and the organization that is back of the 5-gallon sale at the corner filling station.

Away from the oil-production and refining centers the consumer too often thinks of petroleum in terms of a few trade names, and from them the notion of monopoly comes. He has no knowledge of the hundreds of companies and individuals active in the finding and production of crude oil, the 450 refineries owned by more than 200 companies selling the products in the same markets, and finally the keen competition in the operation of distributing and transporting facilities. It is the ceaseless competition of these industrial forces that explains the service and low prices with which the average consumer is familiar.

And so the disease having been diagnosed accurately, the next step is the cure. There is no quick panacea, but there is every reason to believe that a well-directed program of disseminating information will result in a healthy public and oil-industry relationship benefiting everyone concerned.

W. R. BOYD, JR.
President, A.P.I.

GEORGE A. HILL, JR.
Vice president for production

J. HOWARD PEW
Vice president for refining

ERIC V. WEBER
Vice president for marketing

Speakers at A.P.I. Meeting View Industry's Prospects as Brightest in History

Here are highlights of proceedings at the twenty-sixth annual meeting of the American Petroleum Institute. A special section beginning on page 169 presents a summary of the report on the public-opinion survey conducted by the Institute, and a report of the technical sessions. The Journal's editorial staff is represented at Chicago by C. O. Willson, Kenneth B. Barnes, Arch L. Foster, and Charles J. Deegan.

CHICAGO.—Leaders of the petroleum industry as speakers and members of committees pooled their viewpoints on many subjects at the twenty-sixth annual meeting of the American Petroleum Institute in session here November 11-14, and agreed that the industry's prospects 15 months after V-J Day are brighter than in any previous period in the history of the oil business. Technical progress in all divisions of operations as revealed in the several group sessions was outstanding. Petroleum demands in 1946 will be greater than in any peacetime year with further gains assured for 1947.

Registrations for the 4-day meeting pointed to a total attendance of more than 4,000 oil men and those connected with the manufacturing, supply, and supply service organizations.

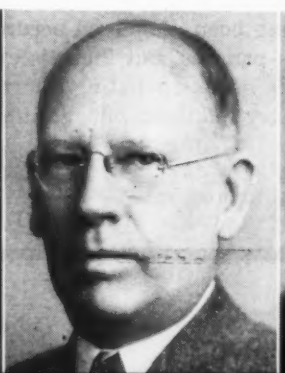
A public-relations program for the coming year sponsored by the Institute which would implement the plans outlined here as a result of the public opinion survey of the past year appears assured. W. R. Boyd, Jr., president of the Institute, in a press conference said that three plans are under consideration involving expenditures ranging from $800,000 to $1,250,000.

In reply to a question Boyd said he favored amendments to the Anglo-American petroleum agreement if they were necessary to make clear that the agreement does not confer federal powers over domestic operations, does not interfere with existing agreements between foreign governments and private American oil companies covering oil operations, and that the agreement's functions are solely of a fact-finding and advisory nature. It is understood that George A. Hill, Jr., vice president of the Institute, before the meeting closes will present a resolution to the board of directors involving clarifying amendments to the Anglo-American pact, similar to that which he presented at the recent annual meeting of the Independent Petroleum Association of America. The resolution at that time was turned down in favor of a resolution which withdrew I.P.A.A. support to the agreement. Boyd said he personally would not favor a program under the United Nations which would give an international body control over the domestic or foreign oil operations of American nationals.

Boyd explained that plans have been completed to make the Marketing Division of the Institute more active and also expand the work of the new Transportation Division. Three widely known authorities on agricultural subjects spoke at the general sessions and reports were made by a committee which has made a

B. BREWSTER JENNINGS
Vice president for transportation

O. D. DONNELL
Treasurer



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ROBERT E. ALLEN
Director, Department of Information

JAMES E. MOSS
Director, Division of Transportation

W. T. GUNN
Director of Refining

C. A. YOUNG
Director, Division of Production

special study of the importance of the farm market to the petroleum industry and how it can be expanded in the future.

The Thursday morning general session was devoted to the common theme, "Looking Ahead," featured by the addresses of Eugene Holman, president, Standard Oil Co. (N. J.); Ralph T. Zook, of Sloan & Zook Co., and J. Howard Pew, president, Sun Oil Co.

All three asserted in the strongest terms that there was absolutely no danger of the United States running out of oil, and that the industry, if allowed to maintain its traditional competitive system, could guarantee the consumers of liquid fuels in this country adequate supplies of constantly increasing quality, at fair prices, for an indefinite period in the future.

All emphasized that we came out of the greatest war in our history with the largest petroleum reserves on record. All took cognizance of the worries and some public statements by those charged with our military defense. They were unanimous in agreeing that the future national defense of our nation, in so far as its petroleum resources were concerned, would be insured best by an alert, progressive, free petroleum industry.

Each speaker reiterated that the petroleum industry wants no special privileges, at home or abroad, and is willing to compete with all comers on the basis of equal opportunity. They recognized, and for their part, accepted it as the industry's responsibility to contribute, in the future, as in the past, to the general increase in the standard of living, by constantly increasing the volume of quality petroleum products available to the public at low prices.

Both Holman and Zook took notice of some of the various proposals that have been made, allegedly in the interest of national defense against some future emergency. These proposals, although varied in nature, amount to locking up oil reserves. They were assailed as negative, artificial, and impractical proposals, made by people who take a defeatist attitude on our oil future, an attitude not shared by the men who know most about it. National defense, it was asserted, cannot be assured by such negative and artificial proposals, all of which would, in one measure or another, depress and stifle the vigor of the domestic industry.

Zook and Holman, representing independents and majors respectively, were in agreement that both independents and majors were in the same boat in so far as the industry's relationship to the public and to the economic welfare of the nation was concerned. They stated that both groups must accept their part of the job in facing industry's responsibility to the public and both agreed that better mutual understanding among the two groups was needed.

Zook suggested that major-company executives should set aside so many days in the year in which to travel to the smaller headquarters towns of the independents and meet them in their own offices, talking things over face to face, getting acquainted with each other's problems.

In regard to the Anglo-American oil treaty, now before the Senate for ratification, Pew said that he, along with other oil men, had originally been satisfied with the present revised treaty, but now was alarmed in view of statements made by the State Department representatives, which to him indicated that the present treaty did not encompass the whole of the policies and control sought by the American Government over the petroleum industry. He said that if the treaty was to be a camel's nose under the tent of restrictive inter-government cartel systems, it became a real danger against which an unrelenting fight should be made.

Holman summarized the responsibilities of the industry as those of continuing to supply customers with oil with sufficient quantities and quality at reasonable prices; to see that stockholders receive the fair return on their investment necessary to attract new capital to an expanding industry; to maintain progres-

FRED VAN COVERN
Director, Department of Statistics

D. V. STROOP
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FAYETTE B. DOW
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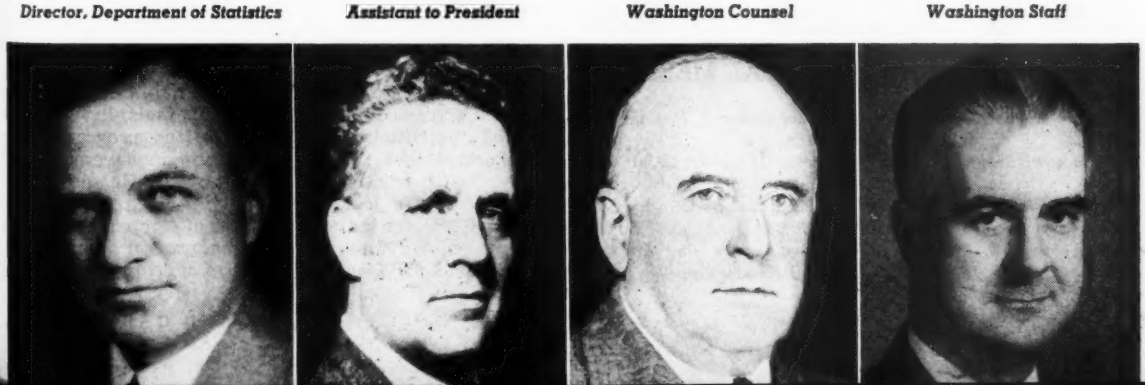


SPEAKERS AT A.P.I. ANNUAL MEETING

Top row: Eugene Holman, president, and Robert T. Haslam, vice president, Standard Oil Co. (N. J.)

Second row: Reese H. Taylor, president, Union Oil Co. of California, and Ralph C. Champlin, Ethyl Corp.

Third row: Ralph T. Zook, president, Sloan & Zook Co., and L. S. Wescoat, Pure Oil Co.

Fourth row: J. A. Krug, Secretary of the Interior, and Alfred P. Sloan, Jr., chairman, General Motors Corp.

sive and enlightened labor policies; and to plan future operations on lines which would give the productive capacity and adaptability needed to cope with any national emergency or danger. He was definitely confident that industry could meet these responsibilities.

On the question of imports, Zook stated the I.P.A.A. position, and reiterated that only a healthy independent group could make a healthy domestic petroleum industry. Holman stated, "I believe there is general agreement that imports can be utilized to fill any gap between the growing demand and the maximum efficient rate of production of our own oil fields."

Reiterating that the industry had all the requisites to meet any future demand, Holman stated the only question was whether the industry would have the opportunity; pointing to efforts now being made to drive a wedge between independents and majors, to distinguish between "big" and "little business," in order to divide them. He asserted that in the petroleum industry, big or major companies needed the little or independents, pointing out that over half the domestic crude refined by his company was bought from independent producers and over half of Jersey's refined products reached customers through independent marketers; that the company chartered transportation from hundreds of small and large companies, traded daily with independent refiners, and simply could not carry on its operations without the complex network of independents and majors that meshed into the industry.

Public Relations Survey Reveals Three Issues

CHICAGO.—Robert T. Haslam, vice president and manager of sales of Standard Oil Co. (N. J.), as chairman of the A.P.I. advisory subcommittee on public relations, made a report at the annual meeting outlining a program of public relations for the entire industry. He explained that the public-opinion survey conducted under the direction of the committee had revealed three critical issues the solution of which is the basis for the committee's program. The issues are:

The impression that the industry holds back new developments.

That the companies get together to fix prices.

That the industry is a monopoly and that there is not enough competition. It was explained that the opinion survey shows that only 42 per cent of the people, on the average, support the oil industry on these issues.

The subcommittee's recommendations call for the employment of a professional public-relations firm which will act as counsel to the committee and will also direct the central-office staff and the public-relations field representatives. The committee recommended that a spectacular nation-wide contest be held to attract the attention of the public to the progressive and essential character of the oil industry. The plan calls for close cooperation between operators and those in charge in carrying out the several phases of the program.

A trade association not only has a responsibility to its membership and the industry it serves but also to the public, Don E. Gilman, of the Western Oil and Gas Association, Los Angeles, emphasized in his discussion of the part that oil trade associations can play in sound public relations.

Ralph C. Champlin, in charge of public relations for Ethyl Corp., outlined five fundamentals in what he termed "essentials" in public-relations programs. He emphasized first the support of top management and adequate financial funds for this work. He also urged the necessity of making an analysis of the problem in the same manner that other phases of company activities are analyzed before an operating program is adopted.

(Additional A.P.I. meeting reports appear on page 349)

THIS 1946 WEEK

REFINING—Continental Oil discloses plans for new construction at Denver refinery to boost capacity to 7,500 bbl. daily. . . . Catalytic-cracking and polymerization units to be erected. . . . ¶Petroleum Heat & Power, East Coast and Chicago marketing concern 50 per cent owned by Pan American Petroleum & Transport, negotiates to buy Taylor Refining Co. . . . Consummation of deal will give Petroleum Heat & Power indirect interest in Coastal Refineries, Inc., through Taylor's present stock holdings. . . ¶Monsanto Chemical to buy Texas City, Tex., styrene plant from WAA for $10,000,000. . . .

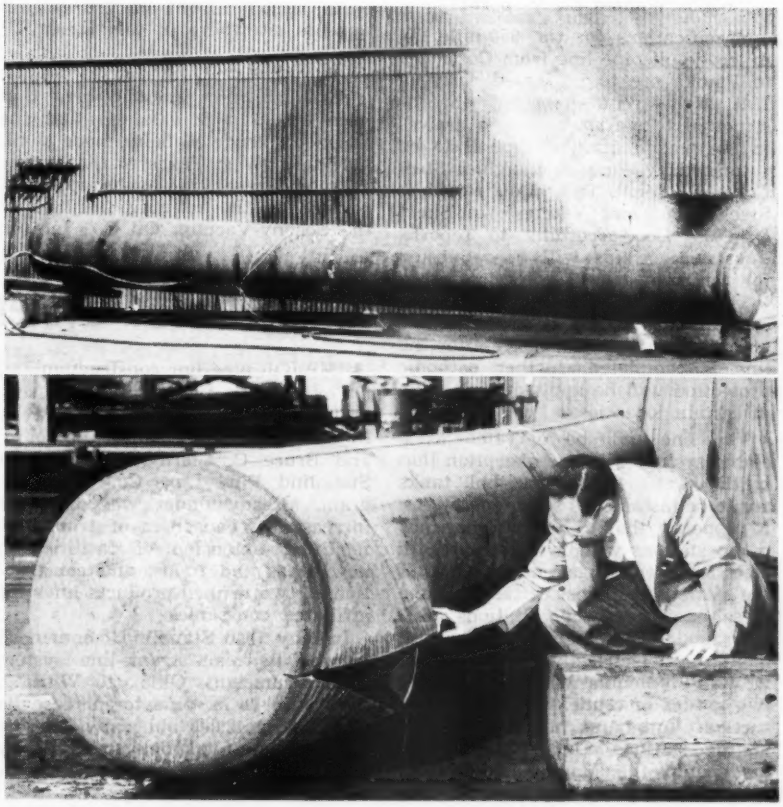
LABOR—More oil companies announce cost-of-living bonus plan for employes, initiated by Jersey Standard organization. . . . Additional companies granting payments include Stanolind Oil & Gas, Stanolind Pipe Line, Phillips, Barnsdall, Continental, Warren, Standard Oil (Ind.). . . . ¶C.I.O. Oil Workers Union hold regional meetings to lay plans for reopening contracts for 25-cent wage raise agreed on by union policy committee at last month's Galveston meeting. . . .

NATURAL GAS—Tennessee Gas & Transmission asks Federal Power Commission approval for $59,545,000 expansion to raise system's capacity to 600,000,000 cu. ft. daily. . . . Half of additional 219,000,000 cu. ft. daily to be gas now being flared. . . . ¶Hope Natural places proposal for second expansion before FPC. . . . New program to bring additional gas from T. G. & T. system, involves loop lines, more compressor capacity at a total cost of about $4,700,000. . . . ¶H. C. Price Co. starts initial work on California section of Texas-Los Angeles gas line. . . . Clearing of right-of-way starts near Blythe. . . . ¶FPC decision on distribution of available Panhandle Eastern Pipe Line gas indicated this week. . . . FPC suspends Panhandle Eastern rate schedule providing for cut in deliveries to Ohio Fuel Gas. . . . ¶December 10 hearing date set by FPC on construction proposals of Natural Gas Pipeline, Texoma Natural Gas, and Chicago District Pipeline. . . . ¶Texas state senate committee continues natural-gas investigation. . . . Industry's efforts to promote conservation to be detailed in sessions this week in San Antonio. . . .

THE GOVERNMENT—Alex M. Crowell, Mississippi Oil and Gas Engineering Committee director, accepts post as head of conservation and reserves unit of Oil and Gas Division. . . . ¶Max W. Ball, now with Michigan Consolidated Gas, reported slated to be named OGD director. . . . ¶Oil-industry officials generally view results of last week's election with satisfaction. . . . Controlled-economy theories appear definitely headed for discard. . . .

TRANSPORTATION—Magnolia Pipe Line announces plans to construct new 20-in. crude line from Corsicana, Tex., to Patoka, Ill. . . . Line due to be in operation early in 1948. . . . Crude will supply affiliated northern Socony-Vacuum refineries. . . . ¶Stanolind Pipe Line reveals plans for major expansion of its system. . . . Drumright-Whiting line to be enlarged. . . .

INTERNATIONAL—Sweden prepares to construct 393-mile pipe line system, with two lines, one to carry crude or heavy fuel oil, the other gasoline. . . . ¶Anglo-Iranian reports output dropped from 11,510,000 bbl. in June to 8,778,000 bbl. in July. . . .



As a part of the rigorous testing program for the 30-in. pipe to be used on the California section of the Texas-Los Angeles gas pipe line, a length of the pipe recently was sealed at both ends and pumped full of water. These pictures show what happened when the pressure was gradually increased until the pipe burst at about 1,800 psi. The pipe bulged and split open near the end. Shown inspecting the damage is Benjamin Miller, consulting engineer. The pipe is being fabricated by Consolidated Steel Co. for Southern California Gas Co. and Southern Counties Gas Co.

Two Pipe-Line Projects Announced; Magnolia Plans New Line

EARLY construction by Magnolia Pipe Line Co. of a 20-in. line from Corsicana, Tex., to Patoka, Ill., a distance of approximately 650 miles, was announced this week by J. L. Latimer, president of Magnolia Petroleum Co. and Magnolia Pipe Line Co.

"This new line will connect our present Texas and Oklahoma lines with those of our Midland Pipe Line Division that extend from East St. Louis, Ill., to Lima, Ohio," Latimer said, "and will provide for the delivery of crude to affiliated Socony-Vacuum Oil Co. refineries at East St. Louis; Trenton, Mich.; East Chicago, Ind., and Buffalo.

"The aerial survey has been completed and the ground survey is now being made and right-of-way purchased. The new line will have a daily capacity of 100,000 bbl. of crude oil. Four stations are planned and will be equipped with electrically driven centrifugal pumps. It is expected that delivery of pipe and pump station equipment will begin in the spring of 1947 and that the line will be ready for operation early in 1948."

Heavy line shows route of Magnolia Pipe Line Co.'s projected 20-in. 650-mile crude lines which will serve northern refineries

Bids Wanted Early in 1947

Specifications for the 650-mile 20-in. crude-oil pipe line from Corsicana to Patoka are to be issued early in 1947, with a request for bids on construction to start when pipe arrives in the second quarter. Pipe is to be furnished by Jones & Laughlin Steel Corp., National Tube Co., Republic Steel Corp., and Youngstown Sheet & Tube Co., according to reports. Construction bids will be requested for this project in six sections.

The pipe is to be protected by coal-tar enamel, felt paper and some glass mat wrapping. Shortly after the line is completed, further cathodic protection will be applied to the line in certain localities.

The line will be operated as a closed system with the exception that in the center two 120,000-bbl. tanks are to be installed to serve operations. It appears that three of the four pump stations will be equipped with electrical centrifugal units. One of the stations is almost certain to have diesel-engine power. Stations will have modern automatic-control equipment and electrically operated gate valves. Shipments will be made in two grades of crude. Operating pressures are to be approximately 700 psi. at the stations. Deliveries will be made into the Magnolia pipe-line system which has capacity in each direction east and west of Patoka of 43,000 bbl., making a total of more than 80,000 bbl. Out of the Patoka area there extend pipe-line facilities of other companies with large capacities.

An announcement of this project appears elsewhere in this issue.

Refining Expansion Probable

Although no announcement has been made, it is assumed that the additional crude oil being made available from West Texas to the Middle West will result in a substantial expansion in the refining facilities of the Socony-Vacuum Oil Co., Inc., in that area. The parent company operates four refineries, which can either be served directly by the new system or through the connecting lines of other companies.

The Lubrite division of Socony-Vacuum Oil Co., Inc., at East St. Louis has a refinery with a crude oil capacity of 20,000 bbl. daily and a cracking capacity of 25,000 bbl. daily. The Wadhams plant at East Chicago has a crude-oil capacity of 23,000 bbl. and a cracking capacity of 16,650 bbl. daily. The White Star division operates a 21,250-bbl. refinery at Trenton, near Detroit. This plant has a cracking capacity of 19,500 bbl. daily. The Socony-Vacuum refinery at Buffalo has a crude-oil capacity of 18,500 bbl. and a cracking capacity of 14,000 bbl. daily. During the war there was considerable expansion in the cracking facilities of these refineries.

Socony-Vacuum has distribution facilities through a large part of the Middle West, and the enlarged pipe line and refining facilities will provide more intensive distribution in that area.

Stanolind System to Be Enlarged

A MAJOR pipe-line construction and extension program involving several areas was announced this week by F. O. Prior, chairman of the board, and Bruce C. Clardy, president, of Stanolind Pipe Line Co. This program, already under way, includes increases in capacities of trunk-line facilities, extension of facilities to new areas and fields, and construction of two refined-products lines for affiliated companies.

In May 1946 Stanolind commenced looping its main trunk-line system from Drumright, Okla., to Whiting, Ind., with 20-in. pipe to increase its capacity by 42,000 bbl. daily, making the average total delivery capacity on this main-line system approximately 250,000 bbl. daily.

The present system consists of two 12-in. lines and one 8-in. line. This will be supplemented by a new 20-in. line from Drumright to Whiting. So far, 148 miles of this new line has been completed between Freeman and LaPlata, Mo., and is now in use. As pipe is received during the coming winter, 119 miles of 20-in. loops will be installed between Drumright and Freeman. In the spring of 1947, approximately 163 miles of 20-in. line will be constructed from LaPlata to Manhattan, Ill. Later, when pipe is available, an additional 202 miles of 20-in. line will be laid to fill in the loops, thereby providing a complete 20-in. system from Drumright to Whiting, a distance of 632 miles.

The capacity of Stanolind's lateral

line from its main line at LaPlata station to Wood River will be increased by completion of a station now under construction, and plans provide for another station to be erected soon, further increasing the capacity of this lateral.

To Extend Texas Line

Early in 1947, Stanolind will extend its 16-in. West Texas-Drumright line, which is now serving the Slaughter and Wasson fields in West Texas, 75 miles south to connect various fields in Gaines, Andrews, Ector and Winkler counties. Two intermediate main-line stations are now being erected on this line between Slaughter and Drumright, which will increase its capacity for delivering West Texas crude into the company's main-line trunk system from 68,000 to 85,000 bbl. daily. As soon as pipe is available, the daily capacity of this West Texas-Drumright system will be further increased to 126,000 bbl. by construction of 265 miles of 16-in. loops.

Stanolind is also considering expansion of its pipe-line system in the Rocky Mountain area. Preliminary plans call for a 12-in. line from the Rangely field, in Colorado, to Wamsutter, Wyo., paralleling the present 10-in. line of Utah Oil Refining Co., and a 10-in. line from Wamsutter to Casper, Wyo. This program would increase the pipe-line outlet for the Rangely field from approximately 25,000 to 50,000 bbl. daily.

Should these lines be built, it would then be necessary to expand the capacity of Stanolind's pipe-line system from Casper to Freeman, Mo., by installing additional stations on the present line and laying approximately 81 miles of 12-in., and 116 miles of 16-in. loops, increasing the daily capacity of this system from 22,000 to 44,000 bbl. This program would provide additional outlets for crudes from the Rangely field in northwest Colorado and from many fields in the Wind River and Big Horn Basin areas of Wyoming.

Gasoline Line From Whiting

In addition to expanding and increasing the capacity of its own crude-oil pipe-line system, Stanolind, acting as agent for Standard Oil Co. (Ind.), is constructing a gasoline line from Whiting to Moorhead, Minn., by way of Minneapolis and St. Paul. This line consists of 10-in. pipe from Whiting to Minneapolis, and 8-in. pipe from Minneapolis to Moorhead. Laying this line started in August 1946, and it is scheduled for completion by December. The line will be placed in operation as soon as pump stations and terminal facilities are completed, which is estimated to be about February 1, 1947.

Stanolind, acting as agent for Wyco Pipe Line Co., will start construction next spring of an 8-in. refined-products line from Casper to Cheyenne, Wyo., and Denver. Right-of-way for this 267-mile line is now being acquired, and the line should be completed and in operation by the middle of 1947. The stockholders of Wyco Pipe Line Co. are Standard Oil Co. (Ind.), The Texas Co. and Socony-Vacuum Oil Co., Inc.

Geologists Hear of Oil Potentialities On the Continental Shelf

by H. Stanley Norman

LOS ANGELES. — More than 500 geologists assembled here last week to hear general and specific papers concerning California oil production and potentialities and discussions related to these subjects.

The medium was provided by the annual meeting of the Pacific section of the American Association of Petroleum Geologists which assembled at the Ambassador Hotel November 8 and 9.

Discussions of oil potentialities of the Continental shelf by Wallace E. Pratt, formerly chief geologist for Humble Oil & Refining Co. and vice president of Standard Oil Co. of New Jersey, and by A. I. Levorsen, Stanford University, were highlights.

Martin VanCovering, Los Angeles, consulting geologist and organizer of the geological forum in the West Coast area which has proven highly popular, was elected president. W. B. Winham, district geologist, Standard Oil Co. of California, Los Angeles, was elected vice president. Clifton Johnson, Richfield Oil Corp., Los Angeles, is the new secretary-treasurer.

W. H. Corey, Continental Oil Co., Los Angeles, was elected president, Pacific section, Society of Economic Paleontologists and Mineralogists.

The Society of Exploration Geophysicists which met concurrently with the other two associations will elect officers in the spring.

In his paper on "Petroleum on the Continental Shelves," Pratt explained that Mediterranean deposition extended to great widths on the eastern shores of North and South America. Conditions inducive to deposition of source material for petroleum formation were described by Pratt. He relied upon literature and his own deductions in reaching the conclusion that deep troughs in submerged areas provide the most favorable conditions. The high percentage of salinity, and the fact that oxidation is retarded in these deep troughs were credited as the factors in accumulation of organic material. These Mediterranean organisms, Pratt explained, must be protected from oxidation in the formation of petroleum.

The western Continental shelf of North and South America, Pratt pointed out, is relatively narrow and is characterized by steep dips.

Sedimentary material may also come to rest on the slopes of the Continental shelves which condition would simulate sand pinchouts and stratigraphic traps already proven productive in this and other land areas.

Levorsen presented data supporting his conclusions that oil and gas may originate in the source beds from which it is produced or that it may migrate from other zones. His paper dealt with the problem of whether oil and gas originate at or very near the point of accumulation or whether these materials migrate from other distant areas of origin. He presented data which tend to support both hypotheses.

The discussion of California petroleum reserves by Graham B. Moody, Standard Oil Co. of California, San Francisco, received high commendation from those attending the Los Angeles meeting. Moody emphasized the increase in California production which rose from 230,263,000 bbl. in 1941 to 326,555,000 bbl. in 1945, a gain of 48.1 per cent. Moody conceded that a few California pools were perhaps harmed by excessive production during the war. He argued, however, that the state's reserve position was improved by the war because of stimulated exploration to deeper sands. In answer to prepared questions Moody expressed the view that the most attractive prospects for new reserves in California are to be found in deeper drilling in currently productive pools. He emphasized that California fields have an estimated ultimate recovery of 41,000 bbl. per acre in comparison with 9,000 to 12,000 bbl. per acre in Texas. He also held that young geologists with imagination and ability to sell management on highly speculative programs will find ready acceptance in California petroleum operations.

Abstracts of papers presented at the A.A.P.G. meeting in Los Angeles were published in the November 9 issue of the Journal starting on Page 92.

International

WORLD-WIDE OIL DEVELOPMENTS

New Agreement to Aid Rebuilding Of Italian Refineries

MILAN, Italy.—In connection with the recent agreement between the Italian government and certain American and British oil concerns, it is reported the board of directors of Azienda Naxionale Idrogenazione Combustibili (A.N.I.C.) at its last meeting in Milan approved in principle an agreement which is to connect A.N.I.C. with the Standard Oil Co. (N.J.) organization.

Though nothing has been published on the agreement, it is interesting to note Italian business quarters report the understanding contemplates the sale of 40 per cent of the A.N.I.C. capital to Jersey Standard. Furthermore, the agreement provides Jersey Standard is to contribute to the reconstruction of the Leghorn refinery of A.N.I.C. and is to use both this refinery and the Bari plant of the same company for refining products to be sold on the Central European and Mediterranean markets for American account.

Russian and Rumanian oil interests have been trying to develop their connections in Italy in recent months, and it is stated that, in view of the difficulties which Russia has encountered in her Italian oil plans, efforts are now being made to push forward the A.P.I.R. representing Romanian oil interests in Italy and the Swiss-Russian subsidiary. A project reportedly has been worked out for the construction of a large refinery by the concern in an Italian port of the Adriatic.

In regard to reports on the supply of oil to Italy, the American maritime strike has greatly influenced the situation. The quantity during September has declined 20 per cent from August. Oil and gas distributed in Italy during September included 19,091 tons of benzine; 31,095 tons of gas oil, 16,869 tons of petroleum and about 173,000,000 cu. ft. of natural gas. Due to the development of road reconstruction, truck traffic showed an increase of 30 to 40 per cent in the last quarter of 1945, and imports of oil and petroleum products have met only the smaller part of Italian liquid-fuel requirements.

Free Oil Trade to Be Speeded

Though larger imports are forecast it is felt that their allocation will remain unaltered because of the necessity of the Italian government to assemble stocks to meet requirements during the transition period between the end of U.N.R.R.A. and the return to free trade. Statements officially made in the Italian press confirm that the government has decided to accelerate the return to the free oil trade.

In official Italian quarters much hope is held in the conclusion of trade agreements with Iran and Venezuela making possible payment of Italian exports to those countries for oil and petroleum products. Pressure is being placed on the Italian government to develop natural-gas resources to relieve the oil shortage. The Po Valley pipe line carries gas from 42 wells in the provinces of Rovigo and Ferrara to Rovigo, Pedova, and Verona where it is used for industrial purposes and house heating.

However, the natural-gas problem remains unsettled. The managing director of the Azienda Metanodotti Padani suggested extending the Rovigo-Ferrara gas line to Bologna and to the Tuscany gas district of Segni, Consandolo, and Bando, but this was rejected by the Italian government. Gas-exploiting companies have increased pressure on the Government to obtain relief from taxes which gas producers pay the state organizations on each cubic meter sold. It is stated operators of gas wells proposed to invest the money saved from taxes on improvement of equipment and in construction of a gas line to connect all existing lines in the Po Valley and to establish a connection with the A.N.I.C. hydrogenation plants at Bari.

Oil Discoveries Held Likely

It should be noted no signs of oil have appeared in the Emilian gas districts, but geologists are voicing the opinion that with drilling to 2,500 to 3,000 m. (8,200 to 10,000 ft.) it is likely that important oil resources will be found in the region. The gas districts in question soon will be visited by Romanian experts.

The question of the exploitation of the Italian natural-gas resources has been raised in Italian industrial quarters. Ugo Baldini, an engineer, in a report submitted at the first national meeting on reconstruction of Italian industry at Milan under the auspices of the General Confederation of Italian Industries, pointed out the importance of natural gas in the economic reconstruction of the country. The old Italian regime has hindered the exploitation of natural gas, Baldini said, while the present government ignores its importance. Italian gas, he said, could be used as fuel in homes, in industries, and in the operation of motor vehicles. Italian gas output could be easily brought, according to Baldina, to 500,000,000 cu. m. yearly, (about 17,100,000,000 cu. ft.) were production not hindered by the government. The total potential gas territory is about 46,000 sq. km. (about 17,800 sq. miles), distributed between the Po Valley, the northern Apennines, and central and southern Italy, and of this only about one-fiftieth is exploited, it was said.

Decision on Legality of Colombia Strike Awaited

Colombia's oil strike, affecting some 10,000 employes, remained unsettled this week. That country awaited the decision of the labor judge on a petition asking that the Tropical Oil Co. strike be declared illegal.

Three other operators affected by the dispute, Andian National Corp., Ltd., Shell Oil Co. of Colombia, and Colombian Petroleum Co., the Barco concession operator, indicated they will join with government and union officials in arbitration.

Army Stocks Meeting Deficits in German Zone

NEW YORK.—With 1946 estimated consumption of petroleum products in Germany set at 2,144,000 tons (14,998,000 bbl) by the Allied Control Authority, indigenous sources in the four German zones will account for 911,000 tons (6,377,000 bbl.), according to a recent report of the Military Governor there.

The U. S. Zone is extremely deficient in petroleum as well as in coal. The two indigenous sources of petroleum products in the U. S. Zone have a monthly yield of around 2,400 tons (16,800 bbl.), mostly low-grade diesel and fuel oils, or about 5 per cent of the U. S. Zone's current requirements, according to the military report which states:

"The distillation plant at Woelfersheim utilizes raw brown coal to produce 500 tons (3,500 bbl.) of heating oil; 700 tons (4,900 bbl.) of tars and 130 gal. of gasoline a month. At the Messel Works, a bituminous oil-bearing slate with 5% per cent oil content is coked to yield about 480 tons (3,360 bbl.) of diesel a month, and 150 tons (1,050 bbl.) of fuel oil and smaller quantities of tar oil, tar pitch, gasoline, paraffin wax, electrode coke, and ammonia sulfate."

In contrast to the Soviet and British zones, the U. S. Zone has no synthetic oil plants, and is dependent on outside sources for approximately 95 per cent of its present tightly screened requirements. The only oil wells within Germany are located in the British Zone, and their only total output as of June 30, this year, amounted to 637,000 tons (4,459,000 bbl.).

332,000 Tons Available

Total petroleum products available in the U. S. Zone, from August 1945 to June 1946, for German civilian requirements, was 332,000 tons (2,324,000 bbl.) Of this total, 104,000 tons (728,000 bbl.), or 32 per cent, came from the British Zone; 13,000 tons (91,000 bbl.), or 4 per cent, from within the U. S. Zone; and 215,000 tons (1,505,000 bbl.), or 64 per cent, from U. S. Army stocks.

For the last half of 1946, monthly allocations of petroleum products from U. S. Army stocks for essential German civilian use in the U. S. Zone have been fixed at 36,650 tons (256,550 bbl.), of which 13,750 tons (96,250 bbl.) are gasoline; 20,000 tons (140,000 bbl.) are diesel oil; and 2,900 tons (203,000 bbl.) are kerosene. These are substantially equal to the U. S. Army stock allocations for German use in May and June. The estimated value of these allocations will be about $800,000 a month.

In addition to the above supplies, the U. S. Zone is slated to receive about 3,000 tons (21,000 bbl.) of lubricants a month from the British Zone. Regarding asphalt, the U. S. Army has agreed to lend 12,500 tons to the Military Government pending some future solution to the problem of asphalt supply. The asphalt is to be used for road repairs and other urgent current needs in the U. S. Zone.

New Guinea Projects Exploration Program

NEW YORK.—Postwar exploration and drilling programs are under way in New Guinea by at least three companies.

Australasian Petroleum Co., Ltd., which spent about $4,000,000 on exploratory work before the war, now has a well down to more than 6,000 ft. at Papua, located in the southern half of that country. More rigs are expected to be in operation shortly. Australasian is jointly owned by Anglo-Iranian Oil Co., Ltd., Standard-Vacuum Oil Co., and Oil Search, Ltd., the last a company financed by private Australian capital. In addition, Australasian plans to put more geological and geophysical parties in the field as soon as possible.

Nederlandsche Nieuw Guinea Petroleum Mij. is planning to build roads into various areas covered by its concession in Netherlands New Guinea. This company is owned by Standard-Vacuum, Royal Dutch-Shell, and California Texas Oil Co., Ltd., the last-named in turn, owned by Standard Oil Co. of California and The Texas Co. This New Guinea company brought in wells here before the war and cemented them off to prevent the Japanese from taking any of the production. A reconditioning program is under way.

Clue Afforded As to British Tanker Request

NEW YORK.—One indication as to why the British may have asked the U. S. Maritime Commission to release more tankers is a report from Sydney, Australia, that oil officials there have asked for British aid in obtaining more petroleum products. A statement in a recent issue of the Sydney Sun said:

"Britain has been asked to place more tankers on the Australian run. Dollar credits are also being examined and Australia is hopeful of obtaining a bigger share enabling her to purchase gasoline from the United States.

"A talking point for Australian negotiators is that British cars are now being exported to Australia in increasing numbers, and to encourage the Dominion market the gasoline allowance must be increased."

International

Swedish Pipe Line Awaits Necessary Equipment

STOCKHOLM.—As soon as the necessary pumps, pipe, and other equipment can be obtained—and it is hoped that the United States will be able to provide the material—393 miles of pipe lines will be built across Sweden. Estimated cost is 20,000,000 krona or about $5,000,000.

According to plans drafted by the Gothenburg Harbor Board, the pipe lines would connect Stockholm, on the Baltic Sea, with Gothenburg on the Kattegat, an arm of the North Sea. The lines are projected over Trollhaettan, through Vaenersborg, Mellerud, Saeffle, Karlstad, Kristinehamn, Oerebro, Kolaeck to the Bergslagen districts and to Vaesteraas. One line would go from Soedertaelje to the coast town of Nynaeshamn.

One 8-in. line is planned for crude or heavy fuel oil and a 4-in. line for gasoline. Sweden's oil construction program also includes plans for refinery and oil storage construction.

French to Spend Large Sum on Overseas Properties

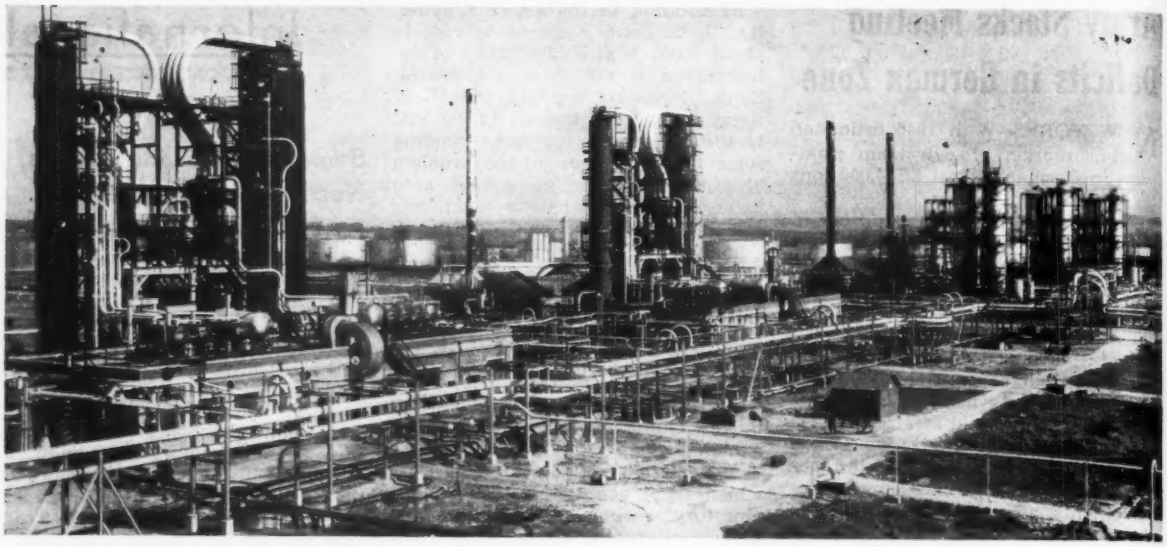
PARIS.—Within the next 15 years approximately $332,000,000 is expected to be spent by French interests in developing overseas petroleum properties, according to a report here in "Marches Coloniaux." The report is based on a program laid out by the French Commission for the modernization of production.

The most important work to be undertaken in French North Africa will be centered around exploration and exploitation over an area comprising 130,000 sq. km. (507,000 acres). An additional 60,000 sq. km. (234,000 acres) will be surveyed by geological and geophysical parties. To take about 6 years, the estimated cost will be 6,000,000,000 francs ($50,000,000). French Equatorial Africa is thought to be the most favorable area.

Anglo-Iranian's July Production Is Down

LONDON.—Anglo-Iranian Oil Co., Ltd.'s July production in Iran dropped to 1,254,000 tons (8,778,000 bbl.) compared with the June production of 1,643,000 tons (11,501,000 bbl.). Production in May was 1,755,000 tons (12,285,000 bbl.).

Total production from January 31 through July 31 was 11,179,000 tons (78,253,000 bbl.).



Before the war the Port Jerome, France, refinery of Standard Francaise des Petroles had a daily capacity of 24,000 bbl. crude and 12,000 bbl. cracking charge. The property suffered heavily from bombing during the war

France Projects Large Expansion of Country's Refining Capacity

by Warren W. Burns

KEENLY aware of the importance of oil in the economy of the nation, French officials are now working toward an almost two-fold expansion of the country's prewar refining capacity by 1955, and at the same time are stepping up exploration efforts, both in France and its colonies.

By 1955, the French refining industry expects to be processing annually 13,000,000 tons (91,000,000 bbl.—about 250,000 bbl. daily). Plans to attain this goal were outlined in the recent report of the French government's committee for the modernization of the French refining industry. Before the war, France's 15 refineries had a yearly output of 8,000,000 tons.

In the French program to develop oil production, 18 rotary rigs already are ordered. Eleven of these are for tests 10,000 ft. and deeper. Marcel Schwob, former chief engineer for Pechelbronn and now New York manager of S. N. Marep, said purchases of drilling and other equipment, which until recently were made through the French government, will henceforth be made direct by Marep on behalf of French homeland, North African, and colonial oil-research companies.

Of the 18 rigs ordered, six are for use in France. Of the remainder, two will be used in Gabon, French Equatorial Africa; two in Tunisia; two in Algeria; and six in French Morocco.

International
WORLD-WIDE OIL DEVELOPMENTS

Total yearly demand for refined products by 1955 in France is estimated at 15,000,000 tons (105,000,000 bbl.). Thus, current predictions are that only 2,000,000 tons (14,000,000 bbl.) of products will be imported. However, crude oil imports will climb steadily unless present exploration and exploitation are particularly successful, for today the only crude production in France is from Pechelbronn field and that is only 75,000 tons (525,000 bbl.) annually. But wildcatting will be greatly stepped up in the next few years.

Meanwhile, French refining interests are casting their eyes over the world for the best available crude supplies, and indications are that Latin America and the Middle East will provide much of the crude needed, at least until France has a greater indigenous source than at present.

Aside from Pechelbronn field, wildcatting in the southwest has, as yet, yielded no crude but important gas fields have been brought in.

Reconstruction is the preliminary step toward refinery expansion in France and currently this is going on, a phase of operations which officials estimate will be finished by the end of 1947, at which time it is hoped that a daily throughput in excess of 100,000 bbl. will have been reached.

The modernization phase comprises two successive stages. In the first stage, which will take about 3 years, refinery throughput reportedly will be stepped up to 10,000,000 tons (70,000,000 bbl.), or a daily throughput of approximately 200,000 bbl. This would be a 25 per cent increase over prewar refinery throughput.

During the second stage, which is slated to take between 1950 and 1955, the French refinery throughput will be stepped up to 15,000,000 tons (105,000,000 bbl.), or to about 290,000 bbl. daily. The actual output of refined products by 1955 is estimated at around 13,000,000 tons (91,000,000 bbl.) leaving a deficit of 2,000,000

PRESENT CAPACITY OF FRENCH REFINERIES

Company and location—	Capacity,* 8-1-46	Expected cap.,* 12-31-47
Compagnies Francaise de Raffinage:		
Gonfreville	12,000	32,000
Martigues	22,000	22,000
Standard Francaise des Petroles:		
Port Jerome	13,000	20,000
Vacuum Oil Co.:		
Gravenchon	3,000	3,000
Jupiter:		
Petit Couronne	4,000	4,000
Pechelbronn Est.:		
Merkwiller	1,500	1,500
Consommateurs:		
Donges	1,600	1,600
C. I. P.:		
Frontignon	1,600	1,600
Berre:		
Berre	10,000	12,000
S.G.H.P.:		
L'Avera	11,000	11,000
Total	79,700	108,700

*In barrels daily.

FRENCH REFINERIES IN OPERATION IN 1939

Company, group and location—	1939 cap. in bbl. dly.
Compagnie Francaise de Raffinage—Cie Francaise des Petroles:	
Low Seine	32,000
Mediterranean Coast	18,000
Standard Francaise des Petroles—Jersey:	
Low Seine	25,000
Societe des Petroles Jupiter—Shell:	
Low Seine	15,000
Gironde	11,000
Societe Generale des Huiles de Petrole—Anglo Iranian:	
North	6,000
Mediterranean Coast	11,000
Produits Chimiques et Raffineries de Berre—Saint Gobain:	
Mediterranean Coast	12,000
Raffinerie de Petrole du Nord—Petrofina:	
North	10,000
Vacuum Oil Co.—Socony:	
Low Seine	5,000
Compagnie Industrielle des Petroles—Socony:	
Mediterranean Coast	4,000
Raffinerie des Petrole de la Gironde—Texas:	
Gironde	4,000
Pechelbronn Est.—Pechelbronn:	
Alsatia	2,500
Pechelbronn Quest—Pechelbronn:	
Atlantic Coast	3,500
Consommateurs de Petrole—Consommateurs:	
Atlantic Coast	3,000
Total	162,000

tons (14,000,000 bbl.) of the estimated yearly demand.

The French government predicts that even in 1955 it will be necessary to import a number of special products, especially lubricants as well as relatively large amounts of fuel oil.

Total petroleum product needs during 1946 are estimated to be slightly under 5,000,000 tons (35,000,000 bbl.). During the last normal prewar year French demand exceeded 6,600,000 tons (46,200,000 bbl.).

Regarding crude sources in relation to the expanded French refining industry, it is evident that officials believe that the bulk of it will come from the Middle East. The projected construction of the 620-mile 16-in. crude-oil pipe line from Iraq's Kirkuk fields to the Mediterranean ports of Haifa and Tripoli, and the 1,200-mile trans-Arabian crude-oil pipe line are considered in the French plans for crude.

Of the 6,970,000 tons (48,790,000 bbl.) of crude imported in 1938, 45 per cent came from Iraq; 33 per cent from the United States; 20.3 per cent from Venezuela, Colombia, and Peru; and 1.3 per cent from other sources.

Of the 1,200,000 tons (8,400,000 bbl.) of refined products imported in 1938, 40.3 per cent came from the United States; 20.3 per cent from Romania where the French had relatively large interests; 10 per cent from Iran; 8.3 per cent from Russia; and 21.1 per cent from other sources.

The prewar French refinery setup is said to have been well adapted to domestic needs at that time. Large-scale refinery construction had been spread over the 7-year period, 1928 to 1935 with additional equipment being added over the next 4 years. However, having been subjected to planned destruction by fire in June 1940, at the time of the German invasion; having been stripped by the Germans after the invasion; bombed by the Allies and caught in the battle for liberation, refinery output dropped considerably.

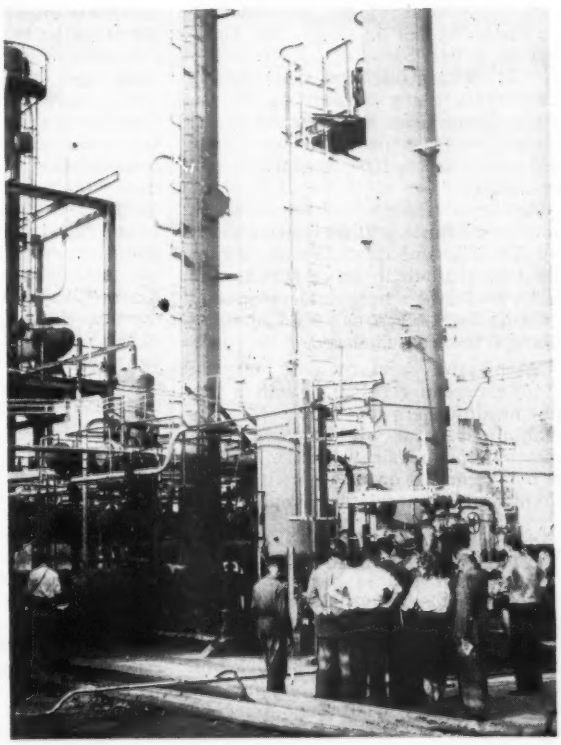
Because of reconstruction work which commenced immediately after liberation, rehabilitated refineries were processing about 30,000 bbl. of crude daily by August 1945. At the beginning of 1946, this was stepped up to 60,000 bbl. daily and as of August of this year the daily capacity was about 80,000 bbl. daily. The French government committee for the modernization of the petroleum industry was organized last winter. Its report was a comprehensive survey of the refining situation in France and what needs to be accomplished in the future.

S. N. Marep (Societe Nationale de Materiel pour la Recherche et l'Exploitation du Petrole) is a foreign as well as domestic purchasing agency which buys everything from deep-test rotary rigs to food for its workers. Marep has offices in France and the United States. Included in its membership are both government-owned and private companies. The New York office address is 44 Beaver Street, New York 4. Companies which comprise membership are as follows:

Regie Autonome des Petroles (R.A.P.); Societe Nationale des Petroles du Languedoc Mediterranean (S.N.P.L.M.); Societe Nationale des Petroles d'Aquitaine (S. N. P. A.); Pechelbronn; Compagnie Generale de Geophysique (C.G.G.); Forex, oilfield contractor; Societe Cherifienne des Petroles (S.C.P.); Syndicat d'Etudes et de Recherches Petrolieres de Tunisie (S.E.R.P.T.); Syndicat d'Etudes et de Recherches Petrolieres du Gabon (S.E.R.P.G.); and Service des Recherches Minieres (S.R.M.)

S. N. Marep, in addition to being a purchasing agency, also keeps its French membership informed on the latest drilling and manufacturing techniques in the United States. Currently, officials and engineers of the French oil research companies are in the United States studying drilling and production developments perfected during the last 5 war years.

During the war years, French producers were unable to obtain necessary maintenance material. Conse-



Erection of a compressor plant is scheduled shortly in the Saint Marcet gas field in France. Right, at a refinery in Saint Marcet area

quently, Schwob explained, S. N. Marep is also concerned with buying material for maintenance and reconditioning of rigs in France, Morocco, and Tunisia.

While S. N. Marep does not buy refining equipment, it will purchase, on behalf of the Regie Autonome des Petroles, material for a gasoline plant to be erected at Boussens, near Saint Marcet. Saint Marcet is located south of Toulouse and is the major gas field in France. The absorption plant, expected to be completed by the end of 1947, will be designed to obtain 130 tons (about 910 bbl. daily of liquid products.

French companies, associated with S. N. Marep and who engage in refinery operations, buy their equipment direct.

The potential output of the Saint Marcet gas field will soon be evidenced, officials said, as R.A.P. is now erecting a compressor plant which will enable R.A.P. to increase the delivery of gas to the city of Toulouse.

During the war, about 90 per cent of the refining industry around Pechelbronn was destroyed. Aside from Gabian, between Toulouse and Marseille in southern France, with a daily output of only a few barrels, Pechelbronn is the only oil field in that country. Production there is 150 tons (about 1,050 bbl.) daily. All other crude is imported, which explains in part why Compagnie Francaise des Petroles has negotiated a deal to purchase all of Pantepec Oil Co. of Venezuela's production over the next 3 years, as one step to obtain the necessary charging stock for its two refineries. (The Oil and Gas Journal, October 12, p. 61, and October 19, p. 93).

Both wildcatting and development drilling is being carried on in the Pechelbronn area. Pechelbronn covers an area of 44,000 hectares (about 108,680 acres) and is 100 per cent privately owned.

An area along the Pyrenees in southern France will be tested shortly by S.N.P.A. and R.A.P. Forex, a contractor, will drill on S.N.P.A. and R.A.P. leases here. Development drilling in R.A.P.'s gas field at Saint Marcet is also scheduled.

Along the western part of the Mediterranean S.N.P.L.M. which has its headquarters at Montpellier, is planning several wildcat tests. Considerable geophysical work in France is being carried on under contract by Compagnie Generale de Geophysique.

Venezuela Production Drops

CARACAS.—Venezuelan crude-oil production of Colon Development Co., Ltd., (Shell) for the 4-week period ended October 28 totaled 386,495 bbl. This is a drop of 19,499 bbl. for the 4-week period ended September 30 when total production was 405,994 bbl.

S.A.E. Engineers Point Way to Postwar Automotive Progress

by Arch L. Foster

MORE than 400 automotive engineers, foregathered in Tulsa for the annual national fuels and lubricants meeting of the Society of Automotive Engineers, signalized the advances, made and making, in lubricating and fuel products required by the automotive industry from the petroleum refining industry Thursday and Friday, November 7-8. Progressive use of additives in lubricants for combating corrosion, engine deposits, and to increase lubrication efficiency was one of the keynotes of the meeting. Methods, new and old, for measuring and rating detonation of motor and aviation fuels were brought up to date, with at least one wartime-developed new assembly of equipment for measuring knock intensity being presented to the group which included the leading automotive engineering authorities in America.

The fate and use of atomic energy is out of the hands and control of the scientists, Dr. H. B. Haas, head of the department of chemistry of Purdue University and a prominent leader in perfecting atomic fission methods during the war, stated before the automotive engineers. Its use and application to beneficial or destructive purposes is in the hands of the human race, to decide on as the world wills, Haas intimated in discussing how the fission of atoms to produce tremendous amounts of energy was accomplished. He stated that we even now obtain only the fraction of a tenth of 1 per cent of total energy bound up in the atom of uranium; scientists are bending their efforts to the total destruction of the atom and the recovery of all the energy stored therein. Starting with the discovery of the Frenchman Becquerelt, 49 years ago, that photographic plates in a drawer with a sample of uranium ore had been fogged inexplicably, Haas traced the development of the isolation of radium by Madame and Professor Curie; the promulgation of the Einstein relativity theory; the small success of Sir Ernest Rutherford, English scientist, in splitting atoms after refusing to leave that work to develop antisubmarine devices in World War I; Briton Chadwick's discovery of the neutron; Madame Curie's daughter's discovery of how to produce artificial radioactivity by bombarding atoms with a stream of neutrons; American Lawrence's development of the cyclotron in which speedy subatomic particles break up atoms, until Austrian Dr. Frisch and German Dr. Lise Meitner (a woman), accomplished and explained the fission of uranium, and confirmed it in Copenhagen in the laboratory of Dr. Bohr, world-famous physicist. Dr. Meitner fled Germany to Holland to take the secret out of Germany and out of the reach of Hitler and the Nazis, Dr. Haas stated.

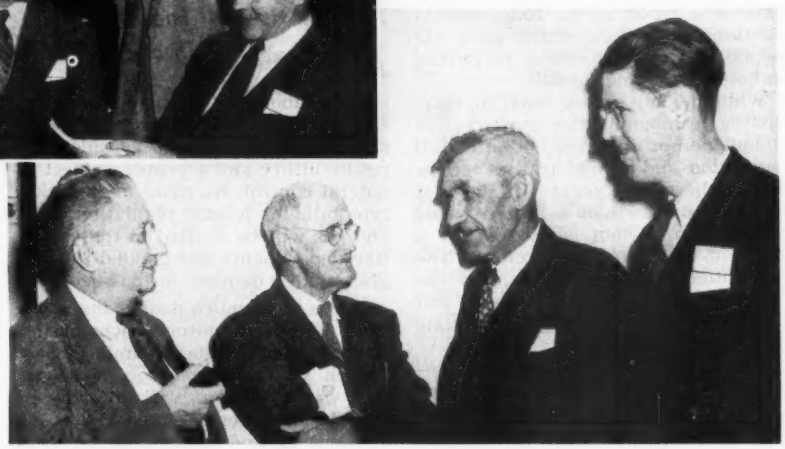
The bouncing-pin detonation indicator has its shortcomings, said T. A. Boyd, head of the fuels division of General Motors Research Corp. and collaborator with the late Thomas Midgley in the discovery of tetraethyl lead, but those have not kept it from being used widely and successfully. Development work has followed two lines, one being that of refining the pin to show better and more consistent results; the other tack has been the efforts to build an entirely different instrument, none of which have supplanted the bouncing pin in general use, Boyd stated.

Sperry Knockometer

The Sperry Knockometer was designed purposely to be responsive to true knock, or 7,500 cycle vibrations, P. J. Costa and J. W. Wheeler of Sperry Gyroscope Co. stated in presenting the results of the use of this instrument in the study of detonation in automotive and aviation engines. Lower vibration frequencies often have been due to other causes than detonation, they said, and with this instrument the results obtained approach more closely the field results in actual automobiles. Results obtained with this model of Knockometer, KM-3, show that reproducibility has been improved by reducing the need for accurate measurement of cylinder-head position; dependability and accuracy have been improved. Conversion factors may be used to tie together the ratings of different fuels by the bouncing pin and the Knockometer, these authors believe. The sensitivity of this instrument is such as to show improvement in accuracy, and its convenience in having only one adjustment which is not critical, which does not affect octane rating and which is maintained over long periods without readjustment, and also in eliminating the guide curve, are all advantageous to the operator, the speakers pointed out.

"We feel that a good part of the difficulties which are being currently

Left: Among the speakers and prominent members of society present at the fuels and lubricants meeting of the S.A.E. in Tulsa November 7 and 8 were, seated, Frank A. Suess, Continental Oil Co., Gustav Wade, U. S. Bureau of Mines, and A. J. Blackwood, Standard Oil Co. of New Jersey. Standing: L. J. Grunder, Union Oil Co. of California; O. M. Setrum, Phillips Petroleum Co., J. S. Bogen, Universal Oil Products Co.; P. J. Costa, Sperry Gyroscope Co., and H. M. Trimble, Phillips Petroleum Co.



Right: The Tulsa S.A.E. meeting attracted such oil refining technologists as B. G. Frichot, Deep Rock Oil Corp.; E. L. Kennedy, Cato Oil & Grease Co., and W. A. Jones and Wade Johnson, Continental Oil Co.

blamed on fuels and lubricants today," said H. L. Moir and H. L. Hemmingway of Pure Oil Co., "are the result of lack of proper crankcase ventilation in internal-combustion engines." In spite of the high-quality fuels which the oil industry has been able to supply to automotive equipment users, these authors said, mechanical "fixes" such as crankcase ventilation are still necessary to compensate for design shortcoming within the engine itself. These authors feel that this crankcase ventilation is one of the improvements which can be made in internal-combustion engines especially to retard the formation of sludges caused by low engine temperatures. Water-jacket temperatures and crankcase-oil temperatures are other design factors which should have a fresh approach, they said. Some of the advantages to be gained from crankcase ventilation include controlled dilution of the engine oil, reduced moisture condensation, removal of blowby gases from the crankcase, as well as varnish-forming and corrosive components; elimination of engine fumes in the vehicle, and removal of solid particles such as soot, lead, and dirt.

Since at least one half the iron found in drain oil comes directly from the upper-cylinder region of the automotive engine, say Norman C. Penfold and Donald S. Gray of Armour Research Foundation of Chicago, reasonably reliable wear data may be obtained by analyzing drain-oil samples, filters, and washings from engines.

One of the outstanding high points of the meeting was the after-dinner talk by Wilbur Shaw, internationally famous race driver, who in a most graphic and telling manner took his hearers through an Indianapolis Speedway 500-mile race "at the elbow of the winning driver" and showed something of the answers which are obtained about automotive design, fuel, and lubrication questions which are not obvious to the layman observer; Shaw is now manager of that world-famous speedway.

In studying the removal of lubricating-oil additives from oils by means of filters in service, a given filter may show markedly different filtering efficiency, depending on the type of detergent oil being filtered, it was reported by Dr. O. C. Bridgeman and E. W. Aldrich, Phillips Petroleum Co., and J. B. Romans of the National Bureau of Standards. Relative efficiencies of various filters with different oils may differ widely or even show reversals, these authors stated. In making these tests a portion of a standardized sludge from a used oil containing no additives and free from the decomposition products of Ethyl fluid was added to the same type of oil as that used in the filter test until a concentrated sludge was formed containing about 4 weight per cent of naphtha-insoluble material. Held at 200° F., this sludge was delivered to the filter. Twenty filters of different commercial types were studied in the efficiency tests.

It was found that after filtering clean oil for 48 hours, these various filters, composed of paper, cotton, or cellulose, or mineral wool, removed from a very small percentage of detergent to a highest of 37 per cent. Use of filter clays in the filter removed from 18 per cent to 100 per cent of the detergent in the oil, most of the tests showing a removal of 60 per cent while in half the number of tests all the detergent was removed. With a filter clay-oil ratio of 40 per cent or more, practically all the detergent was removed from the oils tested, with one or two exceptions.

Fuel Volatility-Performance Relationships

In studying the effect of fuel volatility on the performance of an engine, W. L. Hull, University of Colorado, and Norman A. Parker, University of Illinois, have concluded that the "break temperature" of a fuel is a function of its volatility as measured by the equilibrium-air distillation temperature of the fuel at the 80 per cent evaporated point and the per cent of rated power being delivered by the engine. The more volatile the fuel by this test or the higher the power output by the engine, the lower will be the break point.

Tetraethyl lead and ethylene dibromide do not follow the fuel into the cylinder necessarily, nor does the dibromide necessarily follow the TEL into the cylinders. This fact explains the different amounts of lead deposits in the various cylinders, and the variation in intensity of detonation in different cylinders of an aviation engine. Errors in air-fuel mixture distribution are a function of the fuel volatility, power delivered by the engine, and carburetor air temperature. Lower volatility increasing the error, decreasing the power raises the error and so does lowered carburetor air temperature.

WASHINGTON WATCHING

BY HENRY D. RALPH

Significance of the Election

WASHINGTON.—The oil industry's relations with the federal Government will be on a far more certain basis as a result of the congressional elections last week which gave the Republican Party working majorities in both House and Senate.

While no oil matter was an issue in the campaign, the conservative complexion of Congress will affect all legislation and administrative actions during the next 2 years. For the first time in more than a dozen years Washington is not activated by a spirit of emergency and reform. The motivation now is to clear away the governmental debris of the war and put the nation on a stable, peacetime economy.

Among the now dominant philosophies are removal of emergency controls, less government interference in business, more reliance on free enterprise and less economic planning from Washington, greater faith in businessmen and the capitalist system, and, most important of all, policy making by Congress instead of by "bureaucrats and brain-trusters."

Power of the Purse

This change in government attitude will be felt in every problem involving the oil industry, foreign and domestic. It can be made effective in spite of the fact that the President is of the minority party. The Republicans have the power of the purse, and they intend to use it. They can nullify almost any administration program by withholding funds, and can defeat any new legislation requested by the President. While the President's veto power is still effective, since the Republicans lack two-thirds majorities, this will not result in a complete stalemate in government. For one thing, continuation of much of the former administration program depends on extension of expiring laws, which Congress will refuse to grant. For another thing, a large portion of the minority members of the new Congress are conservatives who will support the efforts of the majority to reduce power of the federal Government over business activities.

While the new Congress will not convene until January 3, the results of the election are being felt already. The administration is jumping the gun on Congress in dropping wartime controls, and in modifying its budget and other programs to be more in line with what Congress is sure to demand. The victorious Republicans are planning a series of conferences here prior to the convening of the new session so as to have a legislative program ready for speedy action.

. . . For the Oil Industry

AS applied to the oil industry, the shift in government policy brought about by the elections means, for example, that there is now no danger that oil will be considered a public utility and a proper subject of federal control. No more of the Ickes type bills for federal regulation of oil and gas will be drafted in the executive departments and handed to Congress with a demand for passage.

Nor is there much danger that Congress itself will initiate such legislation. In the upper chamber, Sen. Joseph C. O'Mahoney of Wyoming, who won reelection, will probably be the chief Democratic spokesman on oil matters, and he has not been an advocate of federal control of the industry. In the new Congress he will no longer be chairman of the petroleum-resources committee, and there probably will be no such special committee, but when he completes the committee's final report and recommendations for a national oil policy he undoubtedly will have in mind the current temper of Congress toward government regulation.

In the House, Rep. Clarence Lea of California will no longer head the petroleum subcommittee of the interstate and foreign commerce committee, but this group has never split on party lines, and has always been opposed to federal interference with the oil industry. The reorganized subcommittee can be expected to continue as in the past largely as a study group and a forum for airing complaints.

Natural-Gas Position

The natural-gas industry is in almost as good a position from the standpoint of federal control. While the election results may or may not temper the report which the Federal Power Commission will present to Congress following its extensive investigation, the chances of restrictive legislation are far less now.

The new Congress will be highly skeptical of requests from regulatory agencies for new legislation to enlarge their powers, and will lean heavily away from further federal interference in any business. Some amendments to the natural-gas act may be made, but only after careful deliberation and for good cause shown. The days are past when the executive branch can get additional controls for the asking, and planned economy is now pretty much in the legislative dog house.

. . . Relative to War Powers

WITH no new federal controls nor bureaucrat-drafted reform legislation in prospect, the first move of the new Congress will be to get rid of much of the present regulation.

If anything is left of price control by January it will be liquidated promptly and permanently—by cutting off funds if not by affirmative repeal. Remaining priority and allocation controls will also be junked except for a few special problems such as rubber. Controls on construction, which have held back many oil-industry projects, will disappear rapidly.

Congress will examine some 500 wartime emergency statutes, and only a few selected ones will be continued for limited purposes. Many of them will be outlawed by a congressional declaration that the war is over, which will automatically end many executive powers within 6 months. While many of these wartime controls are now dormant, business has been hampered by the knowledge that the administration might revive them at any time, and wiping them off the books will remove many uncertainties in industry planning.

. . . In Regard to Tax Relief

THE federal budget will be one of the first problems tackled by the Republican-controlled Congress. There will be quick legislation to reduce personal income and excise taxes followed by a thorough study of corporation and other taxes including some of the "emergency" levies on gasoline and lubricating oil.

How much tax reduction will result is a matter of doubt, but the downward trend will encourage business activity. Even more important is the knowledge that the administration is through with taxation as a means of social and economic reform, and that the federal revenue law will be based on the principles of raising the most money with the least repression of industry.

One aspect of this will be the treatment of the oil depletion allowance and intangible drilling costs. For the past dozen years the Treasury has considered these allowances as "tax loopholes" and has attempted to get Congress to repeal them. Should the

administration repeat this request to the new Congress there is no chance that it will receive as much consideration as in the past.

Substantial reduction of federal expenditures is a definite promise, and the budgets of the executive departments will be sharply pared. While this will receive general commendation, it may mean sharp curtailment of some of the government programs designed to assist the oil industry, such as research activities of the Bureau of Mines and Geological Survey, collection of business statistics by the Census Bureau, and other activities which have the support of industry.

The stripper-well subsidy likewise is in danger of being abandoned in the rush to cut expenditures and get the federal Government out of industry. Funds are available to continue this until April, but new legislation and a new appropriation will be required to continue the subsidy.

The federal claim to tideland oil may be reexamined by the new Congress, regardless of what the Supreme Court may do about it in the meantime. Last year Congress passed a resolution denying all federal title and giving the state governments full jurisdiction over lands under the so-called marginal sea, but this was vetoed by President Truman. Many of the opponents of that legislation will not be members of the Eightieth Congress, and the supporters of states' rights will be in firmer control. Even if the Supreme Court should declare that the federal Government has always owned the tidelands, Congress could give title to the states, and might be able to make this stick over a second veto.

. . . As to Foreign Policy

THE foreign policy of the United States was not changed by the election in so far as concerns basic principles, but its administration is bound to be affected. There will be a split if the State Department does not reflect the conservative attitude of Congress.

Among other things, this will mean less liberal lending to foreign countries and particularly a stiffer attitude toward those governments which lean toward expropriation of American investments and totalitarian systems of economics. The right of American oil companies to be secure in their foreign contracts will be upheld, and business will be encouraged to enter foreign enterprises.

The low-tariff policy will not undergo much modification, since the Republican party claims to have abandoned isolationism and to favor freer world trade. The reciprocal trade agreements act does not expire until 1948, and no attempt to repeal it is anticipated, but the administration will have to be judicious in the duty cuts it negotiates if it wants to avoid severe backfires on Capitol Hill.

The outlook for ratification of the Anglo-American oil treaty is somewhat dimmer than ever. While the Republicans have not opposed it as a partisan issue, they will be more likely to listen to criticisms of it, and they certainly will oppose it if they conclude there is merit to the charges that it opens the door to federal control of the domestic oil industry or to control of foreign operations by an international body.

The Lead Picture Brightens

ELIMINATION of price controls over lead, which went out with all other price controls this week, will make reasonably adequate supplies of the metal available to all principal consuming industries within 3 months, in the opinion of mining experts.

For weeks the tetraethyl lead, automotive, battery, paint, and chemical industries have been protesting to the administration that only a free market can produce sufficient lead to relieve the disastrous shortages facing consumers. They contend that huge quantities of lead scrap are being hoarded for a price rise, that foreign lead will be made available quickly with a higher price, and that domestic producers can open up new veins, hire more workers, and plan long-range exploration and development if freed from government controls. The price of metallic lead might double immediately but will then decline somewhat, it is believed, but during this process a lot of marginal consumers will drop out of the market or turn to substitutes and the prospect of a high price for a short period will bring much metal out of hiding quickly.

Big-Inch Action Unlikely Soon

PROSPECTS for early disposal of the Government's big-inch pipe lines are very remote on the eve of a congressional investigation of this phase of the War Assets Administration.

The special House committee which has been probing WAA for weeks will wind up its investigation with hearings starting November 19 on the entire policy of handling the inch lines, and there is every indication that the study will be a thorough one. For example, when WAA refused to give the committee full details concerning the financial backing of the various bidders, Chairman Roger Slaughter sent a special investigator into the Southwest to find out such data first hand.

The committee intends to challenge both the WAA policy toward the pipe lines and its methods of procedure, and may well request that nothing more be done until Congress has a chance to set a new policy. The committee goes out of existence with the opening of the new Congress, but this will only be the signal for a new congressional overhauling of the entire surplus-disposal program.

The suspicion has been growing that the WAA policy of selling the lines only for petroleum use and not for transmission of natural gas was based on theories of economic planning and government regulation of competition, and that this policy has operated to prevent proper consideration of bids which would bring the Government the best financial return for its investment. If this suspicion is borne out at next week's hearings it is highly probale that the whole disposal project will be held up until Congress can take action.

Continued Rubber Controls

A SPECIAL program for continuing government controls over the rubber industry, regardless of what happens to other wartime controls, will be presented to Congress early in the next session, but this program will be worked out in cooperation with the rubber-producing and consuming industries.

While the president moved swiftly to drop all remaining price controls except sugar and rice, priority and allocation controls still remain for the time being, and Congress will give them a thorough going over, retaining only a few special ones such as on rubber. Controls on construction, which have held back many oil-industry projects, should be out of the picture by spring.

The Office of War Mobilization and Reconversion announced that, on the basis of recommendations from the rubber industry, the Government will continue its program of public purchase and control of importation of natural rubber and will prepare a program for extending authority for government regulation of the rubber industry beyond March 31 when present controls expire. A full report will be made to Congress by OWMR explaining the necessity for controls to maintain operation of the synthetic-rubber industry and to apportion the use of natural crude.

The State Department announced it will participate in a conference in The Hague late this month of the International Rubber Study Group to discuss the problems of countries most interested in rubber.

War Assets Administration announced creation of a new rubber-plants and facilities branch to conduct negotiations for sale to private industry of the Government's $600,000,000 worth of synthetic-rubber facilities.

The Civilian Production Administration announced, as the result of a survey, that tire shortages are still so acute that controls will have to be maintained for some months.

Gasoline Market Manifests Slightly Firmer Trend

REPORTS from marketing sources in the Mid-Continent area early this week indicated a slightly stiffer motor-fuel market and continued though gradual improvement in demand for heating oils.

A refining company representative ascribed the firmness in gasoline to increased consumption from good driving weather over the Armistice Day weekend. Tank-car material, he said, was moving actively. A buyer in the market also pointed out some pipe-line space is now being utilized for movement of No. 1 fuel oil.

The gasoline market has shown seasonal weakness in recent weeks with spot material reportedly going at from ½ to ¾ cent under posted prices. Some market observers have anticipated a pronounced slump in gasoline this winter if refinery runs are held at a high level to meet heating-oil demand with concurrent production of motor fuel.

Of the heating oils, No. 1 and range oil appeared in best demand, though one major company was reported in the market in an effort to obtain No. 2. Furnace oils apparently were not moving heavily to jobbers, but companies were still working to secure their position for the winter.

In New York, prices of No. 2, which fell 2 weeks ago, were holding at 6 cents barge and 6.1 tank car. New York kerosene, and residual prices were reported firm. Ample stocks of No. 5 were reported in New York, but the winter supply outlook for this grade was said to be unfavorable. New York gasoline prices were unchanged.

Motor Fuel Soft on Coast

Orchard consumption and cooler weather in the Pacific Northwest contributed to moderate firming of the distillate fuel-oil market on the West Coast. Prices were unchanged, but movement was accelerating. Motor fuel was soft in California with housebrand offered at 6 to 6½ cents. Offshore and coastwise movement of drummed and packaged products remained blocked by the maritime strike. Accumulating export orders were expected to strengthen the market when the shipping dispute is settled.

Gasoline stocks throughout the nation dropped from 86,423,000 bbl. October 26 to 85,930,000 bbl. November 2. Kerosene stocks dropped 97,000 bbl. to 21,510,000 bbl. November 2. but inventories of other burning oils continued to rise. Reflecting the fall drop in gasoline consumption, the Department of Commerce reported the index of filling stations sales, seasonally adjusted, dropped from 340 in August to 320 in September. Another department report showed sales of wholesalers of petroleum products in September up 16 per cent over September 1945, but unchanged from August. In Austin, Tex., state officials reported September tax-paid gasoline sales at 153,335,458 gal.—down slightly from the record 157,710,173 gal. in August.

I.O.W.U. Plans Drive For Wage Advance

REPRESENTATIVES of local chapters of the International Oil Workers Union (C.I.O.) met last week at Bakersfield in the San Joaquin Valley and made preliminary plans for the drive to increase organized oil-field wages 25 cents per hour. The California meeting was a counterpart of those held or called in other oil-producing sections of the country. The basic program for seeking a wage increase of 25 cents per hour was adopted by the I.O.W.U. steering committee which met several weeks ago at Galveston, Tex.

Representatives of union locals in Ohio, Michigan, Indiana, Kentucky, and Illinois met November 10 in Hammond, Ind., to plan negotiations in reopening about 100 oil-company labor contracts in the five-state area. E. E. Phelps, president of the Hammond local, said there is no uniform expiration date for contracts in the area.

Texas Judge Invalidates Gas Well Shutdown Order

AUSTIN.—State District Judge Roy Archer last week handed down a ruling invalidating the Texas Railroad Commission's order shutting down some 30 gas wells in Carthage field of Panola County, East Texas.

The commission recently ordered Chicago Corp., Clyde H. Alexander of Navarro County, Texas, and W. C. Feasel of Shreveport, La., to shut down the wells for alleged overproduction. The wells were to remain idle until sufficient time had expired to balance the actual production with the production allowed under gas proration.

Attorneys for the Railroad Commission gave notice of appeal of Judge Archer's decision.

Texas Commission Cuts Allowables in Two Fields

November allowables were reduced for two Texas fields and raised for a third last week by the Texas Railroad Commission.

Keystone - Ellenburger pool in Winkler County was cut from 65,403 to 57,000 bbl. daily and Manvel-Miocene field in Brazoria County from 2,838 to 1,702 bbl. In Ector County North Cowden field allowable was increased from 1,979 to 4,120 bbl.

The commission is scheduled Thursday to hear a request of Shell Oil Co., Inc., that its allowable in TXL pool of Ector County be cut 25 per cent.

DEATHS

Clarence Cecil Lemon, 60, sales engineer for International Derrick & Equipment Co., died November 14 in Chicago. He was formerly connected with Continental Supply Co. and had been with International for the past 7 years.

Charles Henry Miller, 71, retired construction superintendent of Phillips Petroleum Co., died November 14 in Fort Worth, Tex.

Homer O. Weber, 57, veteran materials department employe of Phillips Petroleum Co., died November 6 in Bartlesville, Okla.

John S. Aston, 32, development engineer for The Texas Co. in Los Angeles, died from injuries suffered in a field accident November 1. Previous to March 1945, when he was transferred to California, he had worked for The Texas Co. as engineer in Argentina and Venezuela.

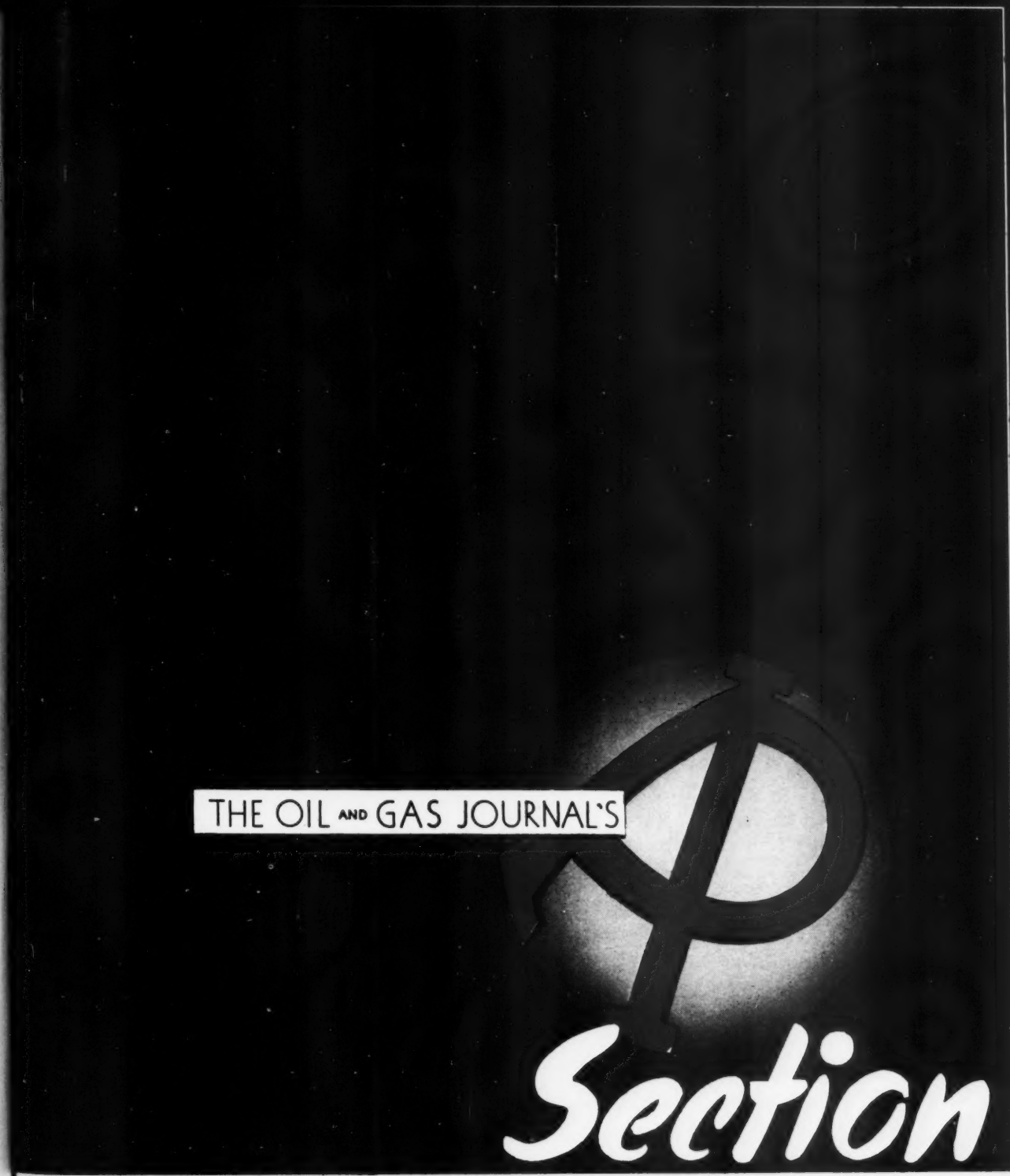
Wilfred G. Talbot, 48, manager for Standard Oil Co. of British Columbia at Victoria, died recently from a shotgun wound suffered accidentally.

Luther Webb, 62, Vernon, Tex., independent operator, died November 8 in Fort Worth.

Reece S. Allen, 73, Northwest Texas operator, died November 8 in Austin.

William Carl Jones, 60, veteran Kansas, Oklahoma, and Texas operator, died November 11 at his home in Oklahoma City.

Jack Robin Snedden, 31, vice president of Jackson, Wise & Snedden, Inc., drilling contractors, Tulsa, and former president of Barnett Supply Co., Shawnee, Okla., died November 12 in a Tulsa hospital.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Those who Know You Think Well of you!

A REPORT

On the following nine pages are published salient points of the results of a survey conducted under the auspices of the American Petroleum Institute, for the purpose of determining the public's attitude toward the petroleum industry. These selected portions will serve to give the reader a conception of the nature and scope of the complete report. The survey, as presented at the Chicago A.P.I. meeting, is divided into three parts. In Part 1 the obviously significant facts revealed by the survey are summarized. In Part 2, highlights of the findings are presented, together with a factual analysis of replies to some of the questions. Part 3 contains the complete tables of replies to all questions, with all cross-analyses.

TO THE AMERICAN PETROLEUM INDUSTRY

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A Public Relations PROGRAM Gets Under Way

TO: American Petroleum Institute

FROM: Opinion Research Corp.

SUBJECT: Directions for the Survey

Soon after the meeting of the American Petroleum Institute in November 1945, we were called by the committee which had been authorized to conduct a survey of public opinion of the petroleum industry, to present our qualifications for the assignment. The assignment called for one of the most comprehensive surveys we, or any other organization, had ever undertaken for one industry. The directions included taking a representative sample of the general public sufficient in size to show differences between opinions in seven different sections of the country. We were also directed to survey representative cross sections of the public in large oil-refining centers and in four large producing areas, manual workers employed in oil refining and producing, and opinion leaders such as teachers, ministers, and editors. Dealers and others in retail distribution were not included in the survey plans.

During the early months of 1946 several pilot surveys were made to test questionnaires and techniques and the final questionnaire and survey plan were approved. Between March 14 and April 13, 1946, our interviewers completed 10,276 personal interviews. The results of these interviews were analyzed and presented to the committee. An independent subcommittee of market research men employed by the petroleum industry came to Princeton to check the analyses and the methods of tabulation. Following their suggestions several additional tabulations were made. In the summer of 1946, the complete tables and cross analyses were presented to the Advisory Subcommittee on Public Relations. The final report includes the reports made at that time, together with a short, illustrated summary of the findings which seem to us to have the greatest public relations significance at this time.

Opinion Research Corp.,
Claude Robinson, President.

What does the Public Think a

BASED ON THE FINDINGS OF THIS SURVEY THERE ARE IN THE UNITED STATES TODAY

69 MILLION adults who say the oil industry tries to serve the best interests of the public.

68 MILLION who say the industry does a job of improving products that is equal or better than that of other industries.

66 MILLION who think that the price of gasoline is reasonable or even low in comparison with other prices.

60 MILLION who would oppose government ownership and operation of the oil industry.

58 MILLION who have a generally favorable impression of the industry.

56 MILLION know that the tax on gasoline is higher than it was 15 or 20 years ago.

56 MILLION think that oil companies try to conserve oil resources.

54 MILLION think that we will still have plenty of oil 100 years from now.

48 MILLION say that oil companies are quick to adopt new developments.

47 MILLION think the oil industry's profit is fair or too little.

46 MILLION can name recent advances in the manufacture of oil products.

45 MILLION say that filling stations give the customer more courtesy and attention than do grocery stores and drug stores.

42 MILLION know someone who works in the oil industry.

39 MILLION say oil companies give their workers good treatment.

34 MILLION believe that there is a great deal of competition within the industry.

34 MILLION say oil companies give their dealers good treatment.

33 MILLION think the industry is not a monopoly.

31 MILLION think of the oil industry as being owned by thousands of small stockholders.

26 MILLION accept the fact that each company sets its own prices to meet competition.

24 MILLION know or guess the total tax on a gallon of gasoline within ½ cent.

13 MILLION report having some discussion about the industry in the last year or so.

11 MILLION estimate that there are more than 100 companies in the industry.

9 MILLION say the industry has the greatest competition in six large industries.

8 MILLION think more favorably of the oil industry than of five other large industries.

7 MILLION think oil gives the steadiest employment of these six industries.

6 MILLION think the oil industry pays the highest wages of the six.

4 MILLION say the oil industry is the best of the six in providing employe benefits.

k about the Petroleum Industry?

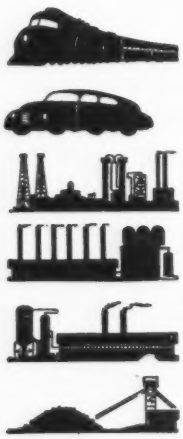
THE STORY ON THE OPPOSITE PAGE IS ALL TO THE GOOD — *But* THERE'S ANOTHER SIDE TO IT

71 MILLION	report having no discussions about the oil industry in the past year or so.
69 MILLION	who think that some of the five other large industries give steadier employment than does oil.
63 MILLION	think more favorably of one of the other five industries.
62 MILLION	say that others of these large industries have more competition.
60 MILLION	say the oil industry does not have as good employe benefits as some of the other large industries.
60 MILLION	think some of the other five industries pay higher wages than the oil industry.
60 MILLION	do not know the total tax on a gallon of gasoline.
48 MILLION	accept the charge that oil companies get together to set prices for their products.
42 MILLION	people do not know anyone in the oil industry.
38 MILLION	can name no recent advances in the manufacture of oil products.
36 MILLION	think the industry is owned by a few large investors.
30 MILLION	rate the oil companies' treatment of dealers as just fair or poor.
28 MILLION	are unaware that the tax on gasoline has increased over the past 15 years.
28 MILLION	think of the oil industry as a monopoly.
27 MILLION	say the oil companies give their workers just fair or poor treatment.
21 MILLION	say that oil companies hold back on new developments.
18 MILLION	think that the industry makes too much profit.
16 MILLION	say that oil companies don't care enough about conservation.
16 MILLION	say there is little competition within the industry.
15 MILLION	say that grocery stores or drug stores show more courtesy and attention than do filling stations.
13 MILLION	would favor government ownership and operation of the industry.
10 MILLION	say the industry doesn't care enough about the best interests of the public.
10 MILLION	say there are 10 or fewer companies in the industry.
10 MILLION	think that the price of gasoline is high in comparison with other prices.
8 MILLION	have a generally unfavorable impression of the oil industry.
4 MILLION	say the oil industry does not do as good a job of product improvement as do other industries.
3 MILLION	think that we will run out of oil in 15 years and this is something to worry about.

THE OIL INDUSTRY LEADS ALL OTHERS IN THE BENEFITS IT PROVIDES TO ITS EMPLOYES – *But* – THE

Public Doesn't KNOW about that

QUESTION: "As far as you know, which industry is the best in providing employe benefits, such as paid vacations, pension plans, and so forth?"



RAILROADS	**61 Per Cent**
AUTOMOBILE	**6 Per Cent**
OIL	**5 Per Cent**
STEEL	**4 Per Cent**
CHEMICAL	**2 Per Cent**
COAL	**1 Per Cent**
ALL SAME	**4 Per Cent**
NO OPINION	**19 Per Cent**

The only one of more than 60 subgroups in the survey that gives the oil industry a higher rating than the railroads for employe benefits is the oil-industry employes themselves. Their ratings:

OIL	**42 Per Cent**
RAILROADS	**38 Per Cent**
AUTOMOBILE	**3 Per Cent**
STEEL	**2 Per Cent**
CHEMICAL	**1 Per Cent**
COAL	**½ Per Cent**
ALL SAME	**4 Per Cent**
NO OPINION	**13 Per Cent**

THE FACTS: Of the six industries under consideration here, the oil industry ranks first on formalized pension plans, group life insurance coverage, mutual benefit associations, stock purchase plans, amounts of dismissal compensation, paid vacations for salaried employes, and paid holidays for hourly employes. The industry places second in paid vacations for hourly employes and paid holidays for salaried employes.

MORE THINGS THAT PEOPLE Don't Know ABOUT OIL

QUESTION: In which industry would you say there is greatest competition among companies?

11% name oil industry.

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QUESTION: Is it your impression that there is a great deal of competition among the companies which manufacture and sell gas and oil, a medium amount, or only a little?

19% say only a little.

9% have no opinion.

•

QUESTION: Can you name any advances made in manufacturing oil products during the past 15 years?

45% can't name any.

•

QUESTION: On the whole, do you think that the oil industry makes too much profit, a fair profit, or too little profit?

23% have no opinion.

•

QUESTION: What kinds of activities and businesses do you think of as being included in the oil industry?

25% can't name any.

•

QUESTION: About how many companies would you guess there are altogether in the oil industry in this country?

42% say don't know.

•

QUESTION: On the whole, how would you say oil companies treat their workers—do they give them good treatment, just fair, or poor treatment?

21% say don't know.

•

QUESTION: How would you rate the way oil companies treat their dealers—do they give them good treatment, just fair, or poor treatment?

20% say don't know.

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Notice how the opinion vacuum fills up on one important issue when the respondents are presented with suggested answers:

QUESTION: What's your idea of how retail gasoline and oil prices are decided?

ANSWER: Fifty-six per cent say don't know, 13 per cent give an answer that implies collusion, and most of the other 31 per cent show some understanding of prices in a competitive market.

BUT —then the respondents were asked:

QUESTION: Which of these statements comes closest to your own idea of how gasoline and oil prices are decided: The oil companies get together and set prices for their products

or

Each company sets its own prices to meet competition?

ANSWER: Get together—57 per cent.
Competition—31 per cent.

Appreciation of the Industry

IN view of the widespread lack of knowledge of the oil industry, it is not surprising to find that the public is not fully appreciative of its merits.

This chapter explores some of the over-all impressions which characterize people's generalizations about the industry.

It also furnishes some examples of how factual knowledge, acquaintance with employes of the industry, and even direct employment in it, appear to lead to more sympathetic attitudes.

1. Oil places among the top five industries of the country in public appraisals based on general impressions.

(a) Even so, no industry is given overwhelming credit for doing a good all-around job, and oil is mentioned by only one person in 25.

This was the first question and it was asked of each respondent before any particular industry or list of industries had been suggested to him. Although emphasis was placed on the "all-around job," it is probable that some people thought back to the war contributions of the various industries while others may have used the recent strikes as their frame of reference.

"Of all the large industries in the country, is there any one which you feel is doing a particularly good all-around job?"

	Per cent		Per cent
Railroads	14	**Electric manufacturing**	2
Automobile	7	**Aircraft**	2
Steel	5	**Coal**	2
Chemical	4	**Shipbuilding**	1
OIL	4	**Textile**	1
Agriculture	3	**Public utilities**	1
Communications	2		
Food manufacturing	2		

	Per cent
All of them	3
None of them	14
No opinion	34

(b) The oil industry again ties for fourth place when people rate six industries for their most favorable impression.

Because respondents were assisted by a list of the six industries, these percentages are about twice as large as in the preceding question. Relative positions of the six industries are much the same, however, with railroads again being chosen by about 3½ times as many people as choose the oil industry.

"Which of these industries do you think most favorably of?"

	Per cent
Railroads	31
Automobile	19
Chemical	12
OIL	9
Steel	9
Coal	5
All same	10
No opinion	6

2. But, whereas the major reasons people give for their favorable impressions of the railroads are specific, the major reason given by those who favor the oil industry is general.

Of the 9 per cent who think most favorably of the **oil** industry—

A fourth reason that it is **essential.**

A fifth refer to its **labor relations and working conditions.**

A sixth mention **good products and service.**

Less than a tenth give any one of varying other reasons.

The "essential need" for oil products as a reason reflects no especial glory to the management of the industry. Three types of essentiality are included in this category: (1) Personal necessity—("I need it for my tractor"). (2) Essential to other industries. (3) Essential to the general welfare.

But of the 31 per cent who choose the railroads (before the strike)—

Almost a third refer to **service.**

A fourth mention **labor relations.**

Another fourth point to the **war job.**

Only a seventh fall back on its **essentiality.**

And among the 19 per cent who select the automobile industry—

One-fourth mention the quality of its **products.**

One-fourth label it **essential.**

A seventh refer to its **product improvement.**

Five-eighths of the 12 per cent who choose the **chemical industry** are thinking of its job of **product improvement.**

In contrast with this specific praise of the chemical industry, about the same proportions (three-fifths to five-eighths) of the few who choose coal or steel resort to saying that these industries **are basic or essential.**

3. Those industries that have been experiencing the most labor trouble are in highest disfavor.

It matters little whether the public reasons that the workers are part of the industry or distinguishes management from labor with a "plague on both your houses" attitude. The result of a strike is the same—the industry as a whole loses favor.

(a) The coal, automobile, and steel industries head the list on the scale of least favorable impressions.

As a result of its strike, the railroad industry may later have ascended further up this negative scale, but there is no reason to suspect that the oil industry has moved from the best position:

"Which industry do you think least favorably of?"

	Per cent
Coal	22
Automobile	11
Steel	10
Chemical	5
Railroad	4
OIL	3
None	28
No opinion	17

The high proportions here who say they do not think unfavorably of any of these industries or who express no opinion points to the frequently demonstrated fact that many people are loath to criticize.

(b) The oil industry is scored down primarily because of scandals and monopolistic tendencies.

Among the 3 per cent who give the least favorable rating to the **oil** industry, these are the two most commonly voiced criticisms.

Automobile and steel are criticized because of labor strife and delays in reconversion.

Coal is blamed because of labor strife and poor working conditions.

The chief criticism of the **railroads** is for lack of progressiveness.

And half of those who think least favorably of the **chemical** industry say this is simply because they "know so little about it."

4. When pinned down specifically to their appraisals of the oil industry itself, seven persons say their general impression is favorable for every one whose general impression is unfavorable.

"Is your general impression of the oil industry a favorable or unfavorable one?"

	Per cent
Favorable	69
Unfavorable	10
Have no impression	15
No opinion	6

(a) Although some reasons given for favorable impressions are general or vague, good solid reasons are given by many people.

69% have favorable impressions of the oil industry

21% say that this is because it is **essential industry**
9% refer to its good labor relations
6% speak of a good job of supply generally, and
3% specifically mention the wartime supply record
5% say its products are good
3% say its prices are reasonable
2% mention satisfactory personal dealings
2% say it's a growing industry
2% point out that it is a large employer
5% give other specific reasons
10% make general comments
5% give no reason

(b) Most reasons given for unfavorable impressions are specific in nature.

"Why do you say that your general impression is unfavorable?"

	Per cent
Total of unfavorable mentions	10
Monopolistic	2
Oil scandals	2
Greed	1
Cartels; international involvements	1
Labor trouble	1
Other specific criticisms	1
General criticisms	1
No reason given	1

5. Over-all impressions reported by different groups of the population reveal how varying degrees of exposure appear to be directly related to the extent of friendliness toward the industry.

(a) This is demonstrated by answers to the above question about general impressions of the oil industry.

Proportions saying their general impression is favorable amount to—

58% of those who **can't describe any part of the industry** and
76% of those who **know that it includes transportation**

66% of the people who **think the industry has 10 companies or fewer** and
77% of the ones who **think it has more than 100 companies**

62% of those who **don't drive an automobile** and
74% of **car owners**

60% of **large-city dwellers** and
73% of the **farmers**

64% of people who **do not know anyone in the industry** and
75% of those who **do**

65% of **New England and Middle Atlantic residents,**
84% of the **public in producing areas,** and
86% of the **public in refining areas**

94% of the **industry's own employes!**

(b) The one outstanding exception to this general rule has important implications for the industry:

People who have had recent discussions do furnish more oil industry adherents (74 per cent) than do those who have held no recent discussions (69 per cent).

But—

A higher proportion (17 per cent) of unfavorable impressions also exists among these people who have held discussions than among any other subgroup studied.

In other words, not only is the industry failing to make use of its personal contacts, but also it is permitting its critics to get in ahead with their sniping.

Awareness of the Industry

TWO disclosures of major importance to the oil industry come forward over and over again as one issue after another is explored in public thinking:

First, a great vacuum of disinterest or unawareness about the industry exists in the minds of large proportions of our citizens.

Second, those groups who have the most factual knowledge and the highest degree of personal contact with the industry, generally speaking, are most friendly to it.

This chapter concentrates its attention on the first of the two points—the large gaps in knowledge among the general public.

1. The public itself is quick to acknowledge the fact that it feels less familiar with the oil industry than with certain other large industries.

Referring to a list of six industries, only one person in sixteen (7 per cent) says that he has more knowledge of the oil industry than of the others:

"Which one of these industries do you feel you know most about?"

	Per cent
Automobile	29
Railroads	23
Coal	8
OIL	7
Steel	7
Chemical	5
All same	12
Don't know	10

2. And relatively few people comprehend the major functions of the industry.

Asked to describe the activities and businesses that are included in the industry, the average person mentions only one or two of its four major functions:

A fourth (25 per cent) of the people are unable to describe any separate part of the industry.

Every second person (53 per cent) mentions some phase of **distribution.**

Every fourth person (25 per cent) mentions **refining.**

A fourth (24 per cent) refers to **production.**

A seventh (15 per cent) mentions **transportation.**

One person in four (24 per cent) thinks of machines or industries which **use** oil products.

3. Nor do many people realize how large is the number of individual companies that goes to make up the industry.

This furnishes one example of how filling in a lack of information might lead to an increase in favorable attitudes: Later discussion will show that people who have the most realistic ideas of the industry's size are least likely to think of it as being monopolistic.

Only one person in twenty (5 per cent) estimates that we have as many as 1,000 oil companies. The median of all estimates is 28 companies.

"About how many companies would you guess there are altogether in the oil industry in this country?"

	Per cent		Per cent
5 or less	4	51 to 100	7
6 to 10	8	101 to 999	8
11 to 15	6	1,000 or more	5
16 to 25	8	Unclassifiable ans.	4
26 to 50	8	Don't know	42

4. The people as a whole exhibit a high degree of ignorance of many other facts which are common knowledge to management.

Witness these examples:

Seven people name the railroads as giving the steadiest employment for every one who selects oil from the list of six industries.

"Over a period of years, which industry do you think gives the steadiest employment?"

	Per cent
Railroads	56
Automobile	10
Steel	9
OIL	8
Coal	5
Chemical	4
All same	4
No opinion	6

For factual comparison, following are average monthly combined discharge and layoff rates for the period April 1943 through March 1946 as derived from the **Monthly Labor Review:**

	Combined discharge and layoff rates (per 100 employes)
Coal mining:	
Anthracite	0.32
Bituminous	0.37
Petroleum refining	0.61
Iron and steel and their products	1.19
Automobile manufacturing	2.14
Chemicals and allied products	2.57

Railroad discharge and layoff rates are not available for this comparison.

5. The industry has wide opportunity to reach the public through personal contact.

(a) Every second person (50 per cent) in the national public states that he knows someone who works in the industry:

22% know someone in **retail distribution.**
9% know workers in the **production** end.
6% know someone in **wholesale** distribution.
6% know someone in **trucking.**
3% know others in **transportation.**
3% know **refinery** employes.
14% know oil workers in unspecified pursuits.

(b) But only one person in every six (16 per cent) reports having had some discussion about the oil industry in the last year or so.

THOSE WHO KNOW YOU WELL THINK WELL OF YOU

Some HIGHLIGHTS

OF THE ANALYSIS

1. **The differences in the attitudes of the various groups and sections of the public are small.** While the analysis chiefly shows the differences in opinion of various groups in the public and different sections of the country, the fact that those differences are small needs emphasis. Generally speaking, all groups of the public have similar opinions of the oil industry and all sections of the country exhibit the same general state of opinion. Except for oil-industry employes, whose loyalty to the industry is unusually great, the over-all results of the survey are applicable to the industry's public relations with all types of people.

2. **That the industry has a sound basis for seeking better public understanding is evidenced by the high regard in which it is held by its own employes.** If the adage that "good public relations begin at home" is sound, the oil industry is on firm footing in undertaking a program to the general public. The acclaim of its employes is unusually high. Favorable opinions of people in its communities are far above those of the general public. The general public has a good opinion of the industry's products and consumer services.

3. **People know very little about the oil industry.** Of the 84 million adults in this country, 21 million are unable to think of any of the activities and businesses that are included in the oil industry; and 38 million are unable to name any advances that have been made in oil technology. People acknowledge the fact that they feel less familiar with the oil industry than with certain other large industries. And, in spite of the fact that half of the public state they know someone in the industry, people generally are unaware of the good employment policies and programs of the oil industry.

4. **The principle of the opinion vacuum is clearly developed by these findings.** This principle is of great importance to public relations work. It might be stated as "where the public has no opinion it is likely to accept the first plausible idea presented to fill that opinion-vacuum." Among the ugly ideas which large percentages of the public are willing to accept are those that the oil industry is a monopoly, holds back new developments, doesn't care enough about conservation, is owned by a few large investors and that oil companies get together to fix prices. The latter idea is willingly accepted by 48 million adults when it is suggested to them, whereas only 9 million have that idea of their own accord at present.

5. **Generally speaking, greater familiarity with the industry leads to greater appreciation of its merits.** The pattern that familiarity, in our case, breeds favor is evidenced by the following groups who are among those most favorable in their thinking toward the industry:

Residents of producing and refining counties.

People in the Southwest.

Car owners.

People who are most aware of the number of companies in the industry.

Those who know oil industry employes.

And the most favorable of all groups are the oil-industry employes themselves.

An exception to this general rule is that teachers are inclined on some issues to be more critical of the industry than the public is.

6. **No current public relations problem arises from the pricing and distribution of the industry's chief product.** An overwhelming majority of the public is satisfied with the price of gasoline.

7. **There are no indications of the need for a defensive approach.** While the public is willing to accept ugly ideas about the industry, only small percentages at the present have convictions hostile to the industry.

8. **Those people who are aware of the large number of companies in the oil industry are much less likely to accept the idea of monopoly.** (There is a substantial minority who do not understand what the word "monopoly" means.) The chief reason given by those who reject the monopoly ideas is that "there are too many companies." Those who are aware that the industry is composed of a large number of companies are generally more favorable on other issues also.

9. **The high opinion of the oil industry among its own employes is not known by the public.** Only about 10 per cent of the public reports having had any discussions about the industry with any of its representatives in the past year or so. Yet half of the adults in the country have friends who work in the industry. Of the workers surveyed and classified as oil employes (white-collar oil workers and filling-station employes are not included in the classification) 95 per cent state that oil companies' treatment of their employes is "good" or "fair" while only 77 per cent of the general public is of the same opinion and 21 per cent of the general public have no opinion. There is little condemnation of the industry for poor treatment in either case. Yet, in spite of their high opinion of the industry, employes of the oil industry are not well acquainted with the facts of the industry. Thirty-four per cent do not hazard a guess as to the number of companies and 14 per cent state they know more about some other industry than the industry they work for.

10. **Members of organized unions are apt to be more hostile to the industry than the general public.** About 20 per cent of A. F. of L. and C. I. O. members advocate government ownership. A fourth (25 per cent) thinks the industry makes too much profit and 46 per cent of A. F. of L. and 38 per cent of C.I.O. members think of the industry as monopolistic.

THOSE WHO KNOW YOU WELL THINK WELL OF YOU

Naphtha Polyforming

by W. C. Offutt*, P. Ostergaard†, M. C. Fogle*, and H. Beuther*

ATTRACTIVE yields of motor gasoline, showing 75-80 A.S.T.M. and 84-93 Research octane numbers without TEL can be produced by the Polyform process as outlined in this paper. The process has the operating flexibility to permit either maximum Polyform gasoline production or maximum butane-butene production with good gasoline yield. Polyforming heavy naphthas or straightrun naphthas for octane improvement offers one means for meeting increasing octane number requirements for motor gasoline.

The process is operated as shown in the accompanying flow diagram (Fig. 1). The naphtha charge is introduced into the top of a high-pressure absorber and comes into contact with the C_3 and part of the C_4 fractions from the stabilizer overhead vapors, absorbing practically all these hydrocarbons. This rich charge passes to the heater, and contains about equal volumes of gases and naphtha; is heated to 1025°-1125° F. at 1000-2000 psig., is quenched with gas oil or tar upon emerging from the coil and is flashed into the fractionator at 300-400 psig., from which the overhead fraction passes to the stabilizer. From the bottom of this stabilizer is taken the Polyform gasoline of the desired vapor pressure while overhead the light vapors pass to the absorber. The authors discussed the process further as follows:

*Gulf Research & Development Co., Pittsburgh. †Process Engineering Department, Gulf Oil Corp., Pittsburgh. (Condensed from the paper by the same title, presented before the group session on Gasoline, Division of Refining, A.P.I., Chicago, November 12).

Yield Vs. Octane Relationship

Gasoline yields from naphtha polyforming depend upon the charge stock, the furnace pressure, the furnace temperature, and the reaction time. The yield of gasoline distillate from a given naphtha is decreased, and its antiknock quality is increased, by increasing either temperature or time. High furnace-outlet temperatures, normally 1,050° to 1,100° F., and, thus, a high level of cracking severity, are permitted by the presence of the cycle gas in the naphtha polyforming operation. The cycle gas allows more severe cracking of the naphtha by lowering the average molecular weight of the furnace charge, and it also minimizes tar and coke formation by its interreaction with many of the olefins produced, some of which would otherwise undergo polymerization to form tar and coke. It is this characteristic of polyforming which permits refinery units to crack naphthas severely over long periods of time for the production of distillates having high A.S.T.M. octane numbers and excellent research octane sensitivity. The conversion to gasoline of both olefins and paraffins in the C_3 and C_4 fractions produced from the naphtha cracking is another feature of polyforming which insures attractive yields of gasoline of high-octane quality.

Fig. 2 is a plot of gasoline yields vs. A.S.T.M. octane number for several different types of naphthas, ranging from a highly paraffinic Rodessa naphtha to a naphthenic California naphtha.

The yield from polyforming naphthas has proved to be a function of the increase in octane number of the polyformed distillate over that of the naphtha charge. The octane number of the naphtha charge varies with the boiling range of the naphtha and with its chemical composition, as represented by the characterization factor. Naphtha polyforming charge stocks vary from 0 to 70 octane number, depending upon the boiling range and relative paraffinicity of the naphtha. Thus, the octane improvement required to produce a certain octane-number gasoline from naphtha varies over a wide range. The stocks with high initial octane numbers and low characterization factors . . . suffer small loss in yield when polyformed to A.S.T.M. octane numbers in the

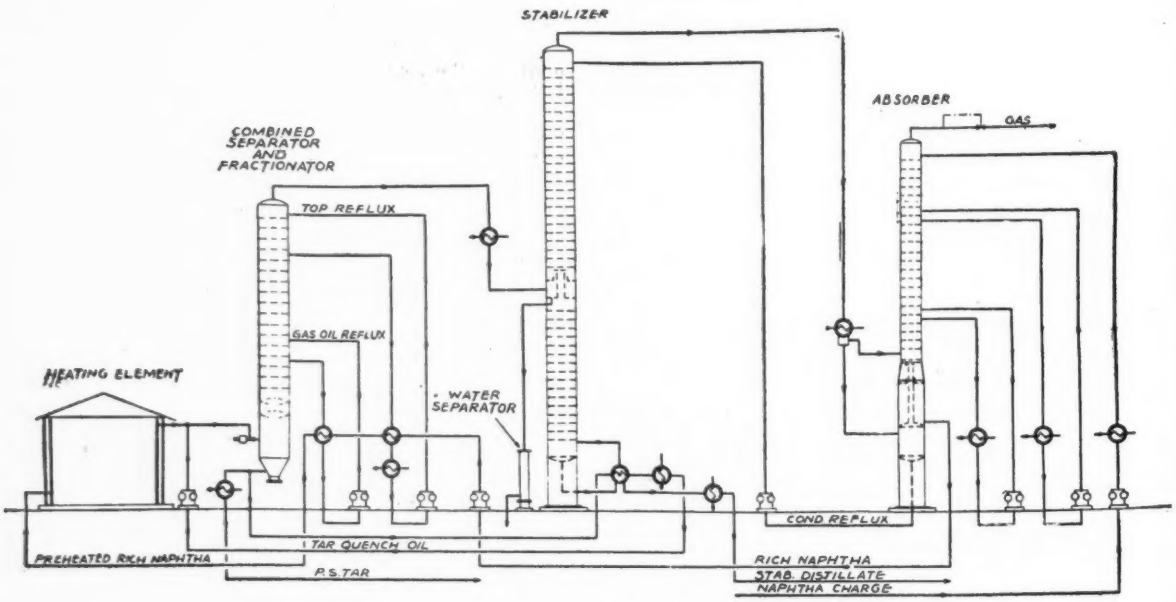

Fig. 1—Naphtha Polyform unit

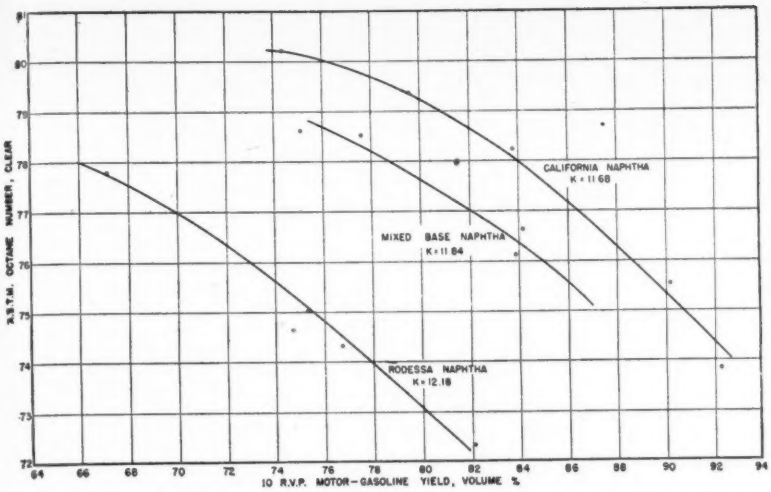

Fig. 2—Polyforming various types of naphtha—gasoline yield vs. A.S.T.M. method octane number

range of 76 to 80. Low-octane naphthas incur somewhat greater losses when polyforming to 76 octane number or higher.

A useful correlation has been developed relating the yield and octane improvement from naphtha polyforming to the characterization factor and A.S.T.M. octane number of the naphtha charge. The correlation in the form of a nomograph, shown in Fig. 3, makes it possible to calculate quickly the yield corresponding to a given octane number of Polyform distillate by knowing only the original octane number and characterization factor of the charge. This chart was developed for 1,500-psi. polyforming operations producing a gasoline distillate at 10 lb. R.v.p. It is recommended only for straightrun naphthas which have 90-per-cent points below 400° F. . . .

Pressure has an appreciable effect

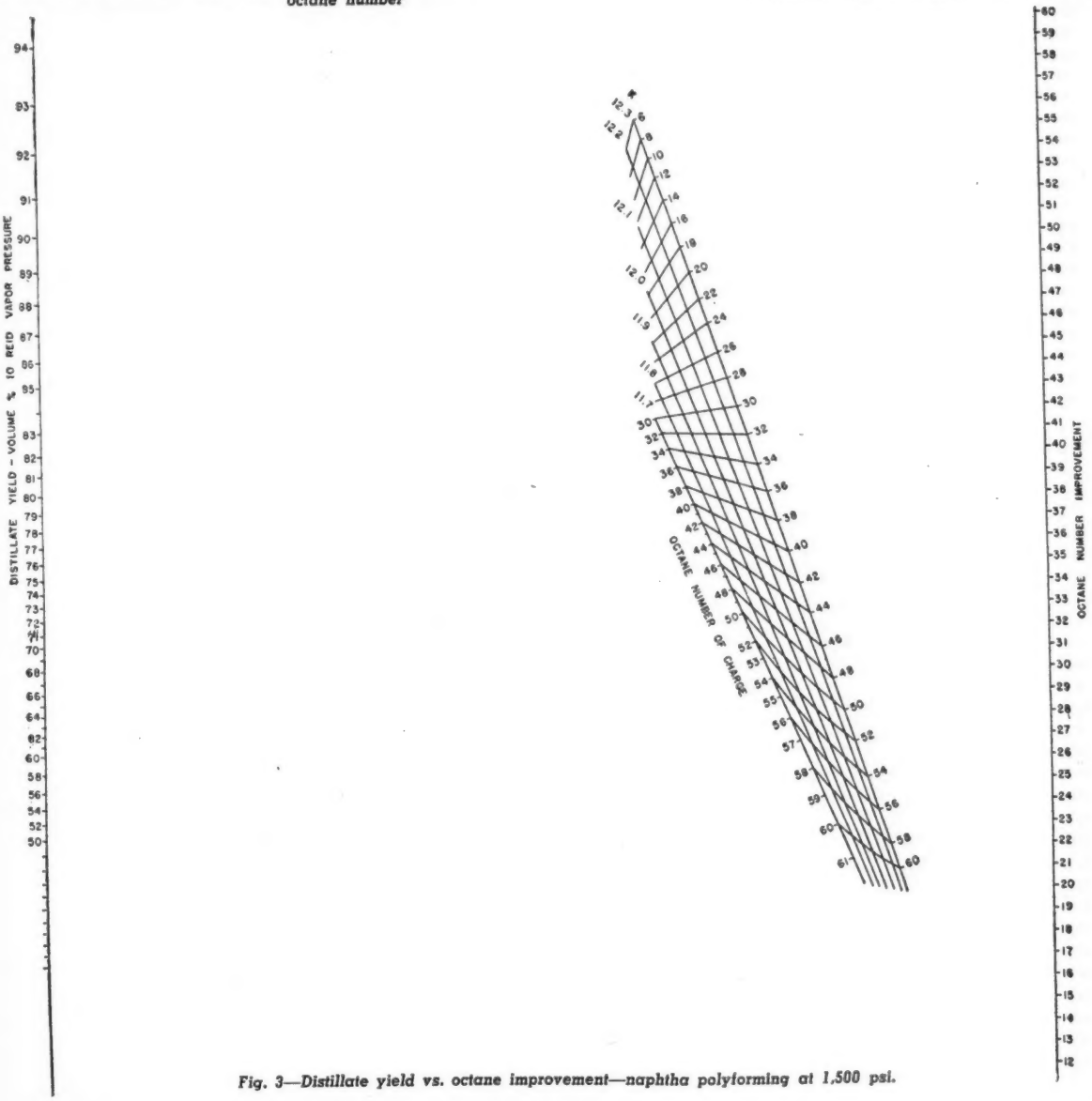

Fig. 3—Distillate yield vs. octane improvement—naphtha polyforming at 1,500 psi.

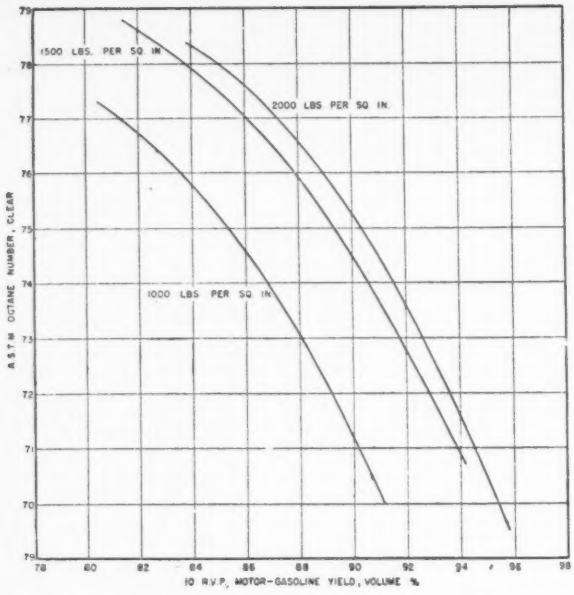

Fig. 4—Polyforming Eastern Venezuela naphtha—effect of pressure

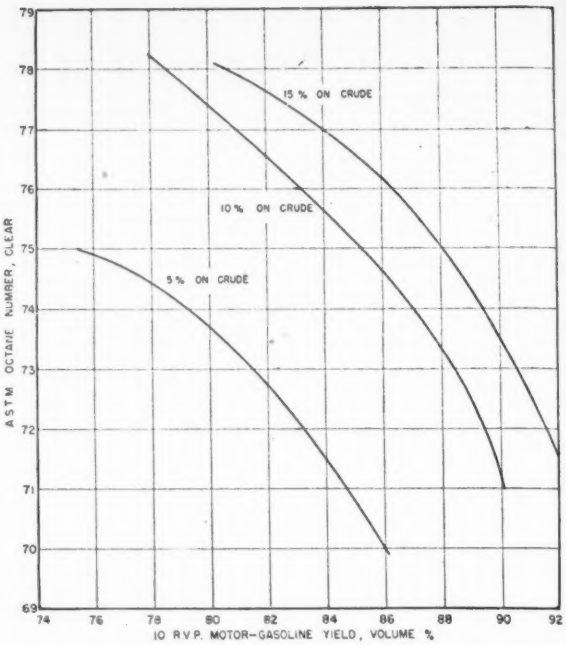

Fig. 5 — Polyforming various boiling-range Eastern Venezuela naphtha cuts—gasoline yield vs. A.S.T.M. octane number of polyform distillate

on the yield-vs.-octane-number relationships obtained by naphtha polyforming. An increase in furnace-coil outlet pressure from 1,000 to 1,500 psig. results in a sizable gain in yield for a given octane number (about 4 per cent by volume). A further increase in pressure from 1,500 to 2,000 psi. produces an additional increase in yield of only about 1 per cent by volume. Yield-vs.-octane-number curves for three series of polyforming runs on a heavy eastern Venezuela naphtha are shown in Fig. 4 for pressures of 1,000, 1,500, and 2,000 psi. Yields obtained when polyforming eastern Venezuela naphtha at the various pressures to a constant A.S.T.M. octane number are shown in Table 1. These results are typical of the effect of pressure in naphtha polyforming. Although the operations at 2,000 psig. produced the largest yield of gasoline of a given octane number, a study of differential investment costs indicates that 1,500 psig. is near the optimum polyforming pressure.

Effect of Boiling Range of Naphtha Charge

There is no general rule that can be used in selecting the portion of a straightrun gasoline which should be charged to a polyforming operation. As the Polyform process is well adapted to the handling of any naphtha fraction, it is entirely a problem of economics and octane-blending requirements for the refinery operations in question. Usually a light straightrun fraction, which is sufficiently high in quality for blending into the finished plant gasoline, is excluded from the polyforming charge, and the remaining heavy naphtha is polyformed to a desirable antiknock level.

A comparison of the polyforming of three naphtha fractions representing 5, 10 and 15 per cent of eastern Venezuela crude indicates the effect of boiling range of naphtha charge upon the yield and quality of gasoline produced from the full 28.5 per cent of gasoline originally present in the crude . . . Yield-vs.-octane-number relationships for polyforming of the three naphthas are plotted in Fig. 5, showing A.S.T.M. octane numbers. The wider-boiling naphthas produced

TABLE 2—POLYFORMING OF EASTERN VENEZUELA NAPHTHAS
Effect of Boiling Range

Source of Polyformed Distillate—	Heavy naphtha 5 per cent on crude	Intermediate naphtha 10 per cent on crude	Light naphtha 15 per cent on crude
Yield of polyformed distillate, per cent by volume on naphtha	70	83.5	86.5
A.S.T.M. Octane No. of polyformed distillate:			
Without addition of TEL	76	76	76
With addition of 3 ml. TEL	83.5	84.5	84.5
Research Octane No. of polyformed distillate:			
Without addition of TEL	87	86	87
With addition of 3 ml. TEL	95	95.5	95.5
Blend composition, per cent by volume:			
Polyformed distillate	13.0	30.8	49.4
Straightrun gasoline	87.0	69.2	50.6
Yield of blend, per cent by volume on crude	27.0	26.9	26.5
Yield of blend, per cent by volume of full range gasoline	94.7	94.3	92.8
A.S.T.M. Octane No. of blend:			
Without addition of TEL	67.3	69.6	74.0
With addition of 3 ml. TEL	83.4	84.4	86.5
Research Octane No. of blend:			
Without addition of TEL	70.1	73.6	80.1
With addition of 3 ml. TEL	86.6	88.7	92.0

TABLE 1—POLYFORMING EASTERN VENEZUELA NAPHTHA
Effect of Pressure

Furnace pressure, psi.	1,000	1,500	2,000
A.S.T.M. octane No.	76.0	76.0	76.0
Yields, per cent by volume:			
Gasoline (10 lb. R.v.p., 400° F. end point)	83.5	87.8	88.9
Gas (C_2 and lighter), fuel-oil equivalent	11.8	8.1	6.5
Tar	4.3	4.1	5.2

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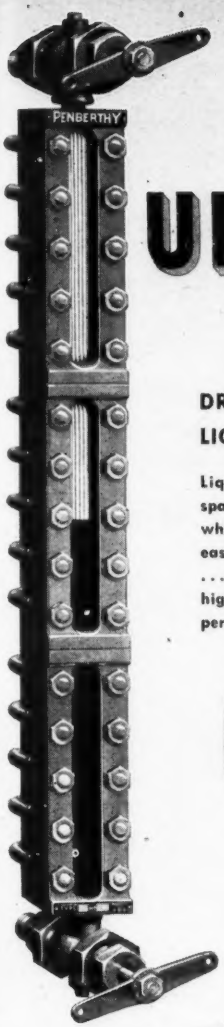

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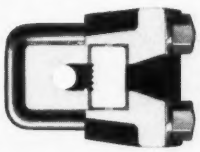

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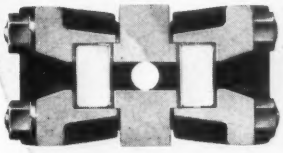

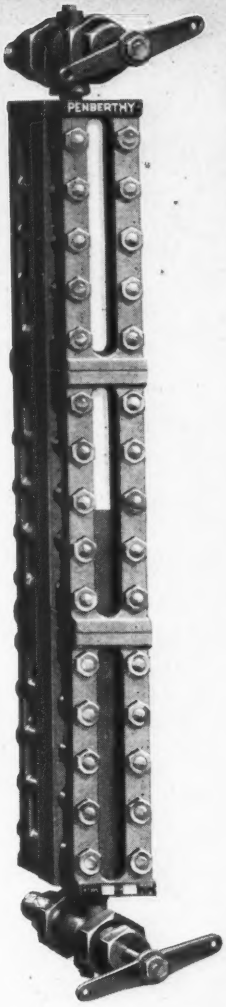

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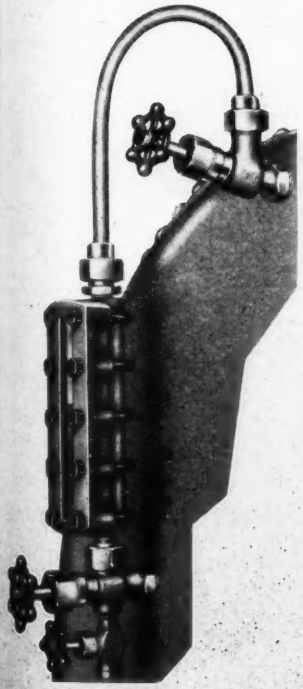

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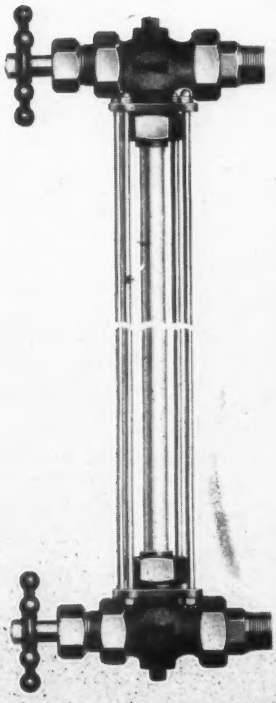

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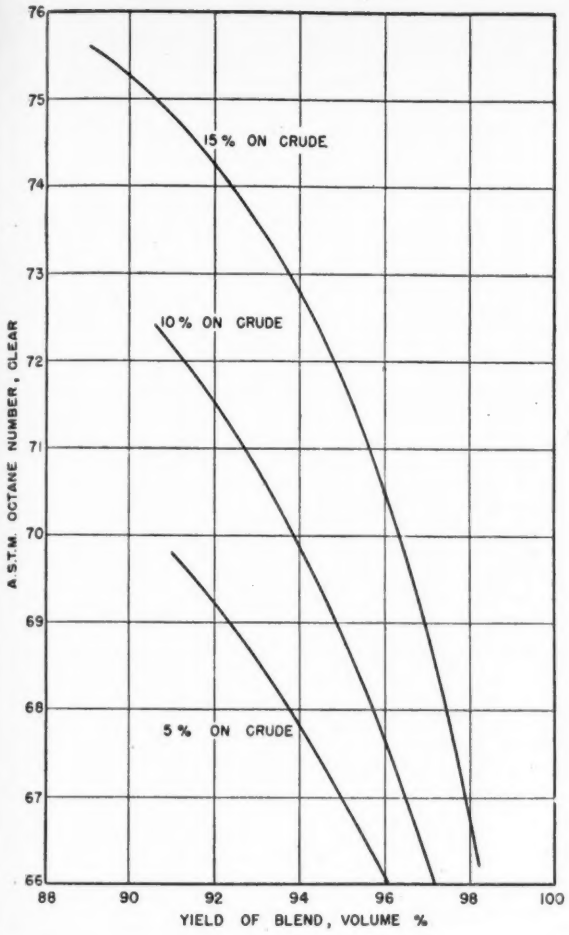


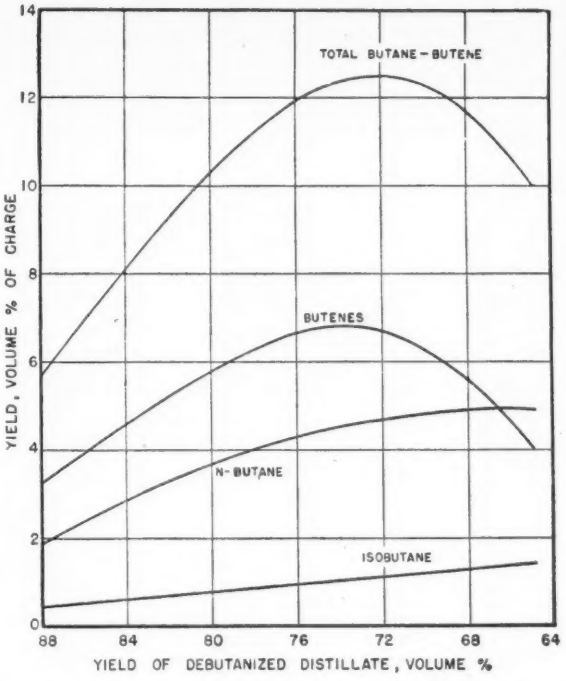


Fig. 6—(Left) Polyforming various boiling-range Eastern Venezuela naphtha cuts—A.S.T.M. octane number vs. yield of blend of straightrun gasoline and polyform distillate

Fig. 7—(Above) Polyforming an Eastern Venezuela naphtha for butane-butene production—butane-butene yields vs. yield of debutanized distillate

higher yields of distillate of a given octane number, because of the higher octane number of the charge. Research sensitivity and lead response of the Polyform distillate appeared to be independent of the boiling range of the naphtha charge.

Blends of Polyform distillates from the three naphthas with their complementary straightrun gasolines resulted in the yield-vs.-octane-number relationships plotted in Fig. 6. The advantage of polyforming the naphthas representing 10 or 15 per cent of the crude is obvious, especially when the maximum over-all octane level is considered. The research-method ratings are benefited particularly by polyforming the wider naphtha fractions. A comparison of yields and octane numbers of blends of the Polyform distillate and their complementary straightrun gasolines, when polyforming each of the three naphthas to a constant octane number of 76, is shown in Table 2. This is a practical type of comparison which shows the substantial improvement in gasoline quality by increasing the volume of naphtha charged to the Polyform process. The decrease in yield based on crude was small.

Table 3 demonstrates the effect upon the A.S.T.M.-research spread for the over-all gasoline blend when broadening the naphtha-charge boiling range. As the percentage of Polyform distillate in the blend increases, the high research sensitivity of the Polyform gasoline becomes apparent. The research ratings of Polyform gasolines are a function of their A.S.T.M. octane numbers; the spread between A.S.T.M. and research ratings increases as the A.S.T.M. octane number becomes higher. Polyform distillates having unleaded A.S.T.M. octane numbers of 76 to 78 rate between 85 and 92 (unleaded) by the research method.

TABLE 3—A.S.T.M. RESEARCH OCTANE SPREAD OF BLENDS OF POLYFORM DISTILLATE WITH STRAIGHTRUN GASOLINE FROM EASTERN VENEZUELA NAPHTHA

Charge to polyform unit, per cent by volume of crude—	5 Per Cent	10 Per Cent	15 Per Cent
Gasoline yield (10 lb. R.v.p., 400° F. end point), per cent by volume	92.0	92.0	92.0
A.S.T.M. octane No.	69.2	71.5	74.3
Research octane No.	71.4	75.5	80.8
A.S.T.M.-research spread	2.2	4.0	6.5

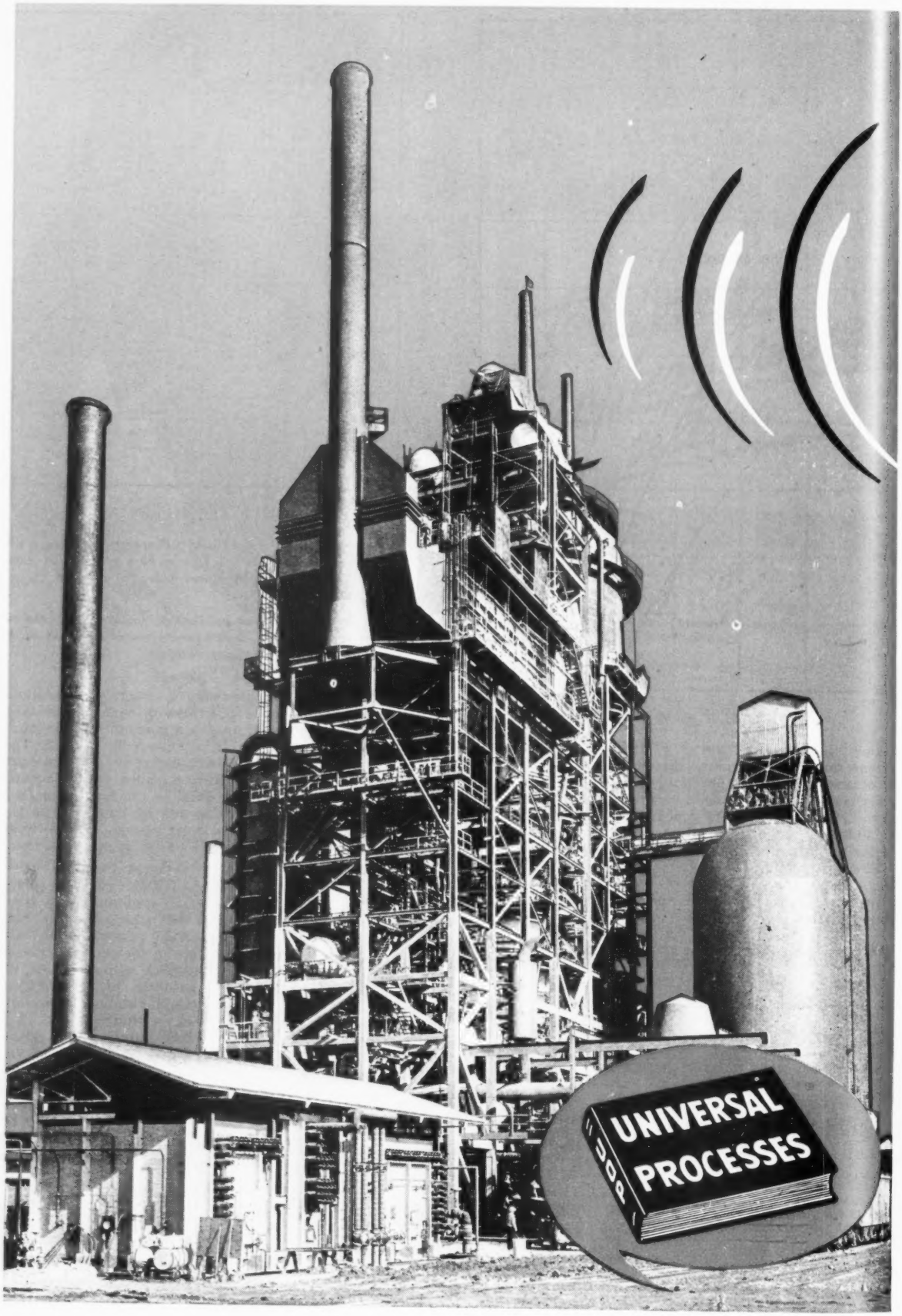
TABLE 4—POLYFORMING PENNSYLVANIA-MID-CONTINENT NAPHTHA FOR MAXIMUM BUTANE-BUTENE PRODUCTION
Effect of Pressure

Pressure, psi.	*400	1,500	2,000
Debutanized distillate:			
A.S.T.M. octane No.	75	75	75
Yield, per cent by volume	66.5	64.7	64.4
Butane-butene:			
Yield, per cent by volume	13.0	16.7	14.1
Unsaturation, mole per cent	68	62	55

*200 per cent gas dilution used.

Operating for Maximum Butane-Butene Production

In many refinery-operating schedules, it is desirable to produce a maximum yield of butane-butene for use in alkylation or for other purposes. In such a case the stabilizer of the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During this period the unit processed approximately 8,000,000 barrels of fresh charge exclusive of recycle. Early in the run it was operated largely on straight run gas oil of 30° or higher A.P.I. gravity. At times various naphthas, both straight run and cracked, were charged as supplementary charge to maximize aviation gasoline production. Since the close of the war, the charge was gradually made heavier and for the past several months has been primarily a heavy California waxy distillate of high viscosity averaging 22° to 23° A.P.I. gravity.

Since the beginning of post-war operation, catalyst costs have averaged approximately two cents per barrel of fresh feed charged. Catalyst activity has been maintained at relatively high levels as indicated by the space velocities employed during the run.

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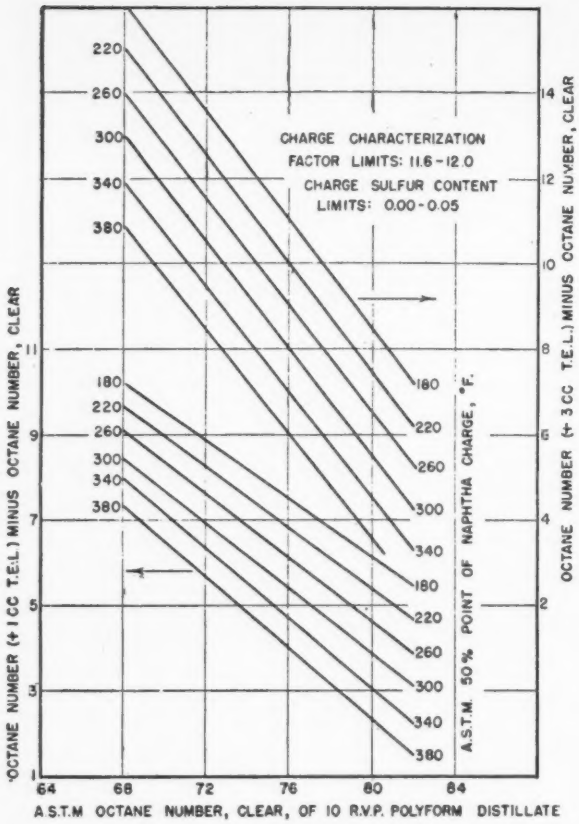
CHARGE CHARACTERIZATION FACTOR LIMITS: 11.6 - 12.0
CHARGE SULFUR CONTENT LIMITS: 0.00 - 0.05
OCTANE NUMBER (+ 1 CC T.E.L.) MINUS OCTANE NUMBER, CLEAR
OCTANE NUMBER (+ 3 CC T.E.L.) MINUS OCTANE NUMBER, CLEAR
A.S.T.M. 50% POINT OF NAPHTHA CHARGE, °F.
A.S.T.M OCTANE NUMBER, CLEAR, OF 10 R.V.P. POLYFORM DISTILLATE

Fig. 8—Relationship between lead response, A.S.T.M. octane number, and charge at 50-per-cent point for 10-R.v.p. polyformed distillates

Polyform unit is operated as a depropanizer, and essentially all butane-butene is removed from the unit with the gasoline. The quantity of butane-butene in the recycle gas is maintained at a minimum, the recycle gas stream consisting almost entirely of propane and propylene. The amount of butane-butene that can be obtained from a Polyform operation depends upon: (1) The cracking severity; (2) the furnace pressure; and (3) the type of naphtha charged. The efficiency of the stabilizer affects the yield of butane-butene from a given operation. In a Polyform furnace, butane-butene is produced by cracking of the naphtha, and is simultaneously consumed by previously mentioned alkylation, polymerization, and other gas-conversion reactions. At milder furnace operating conditions, an increase in cracking severity increases the production of butane-butene more rapidly than it increases the reactions consuming butane-butene. The net yield of butane-butene becomes larger with increasing cracking severity, until a point is reached where the conversion of C_4 hydrocarbons in the high-temperature section of the cracking coil exceeds the production of butane-butene from the naphtha. Higher cracking severities result in a decrease in the yield of butane-butene. The point of maximum butane-butene production varies somewhat from one naphtha to another, but it usually occurs in the range of operating conditions producing the highest octane distillates within commercially economic yields. This is illustrated by Fig. 7 which shows the yields of butane - butene plotted against yields of debutanized distillate from a series of runs of increasing severity, polyforming 48.2° A.P.I. eastern Venezuela naphtha. The peak yield of butane-butene in these runs was 12.5 per cent by volume, and it occurred at a furnace-outlet temperature of 1,090° F. when producing a debutanized distillate having an A.S.T.M. octane number of 79. The unsaturation of C_4 cuts remained nearly constant at about 55 per cent throughout the commercial severity range until the butane-butene yield passed its maximum. . . .

Higher yields of butane-butene were produced at a polyforming pressure of 1,500 psig. than at either 400 or 2,000 psi. Table 4 gives the total yield of butane-butene obtained from polyforming operations producing debutanized distillate having a constant motor-method octane number of 75 at pressures of 400, 1,500, and 2,000 psi. Although the operation at a pressure of 1,500 psig. produced the largest yield of butane-butene, the unsaturation of the C_4 cut appeared to increase with decreasing pressure.

Lead Susceptibility

The lead response for Polyform distillate has been summarized in Fig. 8 relating lead response with A.S.T.M. octane number of the Polyform distillate and the 50-per-cent point of the naphtha charge. The chart is limited to Polyform distillate obtained from naphthas with characterization factors ranging from 11.6 to 12.0, and with sulfur contents up to 0.05 per cent by weight.

References

1. J. Bogk, P. Ostergaard, and E. R. Smoley, "The Naphtha Polyform and Gas Reversion Processes," Proc. A.P.I. (3) 17-36 (1940).
2. W. C. Offutt, P. Ostergaard, M. C. Fogle and H. Beuther,. "Naphtha Polyforming with Outside Gas," before Group Session on Refining during the Twenty-sixth Annual Meeting of the American Petroleum Institute, in the Stevens Hotel, Chicago, Ill.
3. J. H. Hirsh, P. Ostergaard, and W. C. Offutt, "Correlation of Operating Variables in the Polyform Process," before Group Session on Refining during the Twenty-sixth Annual Meeting of the American Petroleum Institute, in the Stevens Hotel, Chicago, Ill.

Naphtha Polyforming With Outside Gas

By W. C. Offutt,* P. Ostergaard,† M. C. Fogle,* and H. Beuther*

A.P.I. Abstract

THE Polyform process is an attractive means of simultaneously converting low-octane naphthas and renegade refinery gases, both paraffins and olefins, to high yields of gasoline having A.S.T.M. octane ratings of 75 to 80 and research octane ratings of 84 to 93, without the addition of tetraethyl lead. Comprehensive studies of naphtha Polyform operations charging outside refinery-gas streams are presented for the first time. The effects of varying amounts and compositions of outside-gas charge are discussed with respect to yields and quality of products obtained with a wide range of naphtha charge stocks. The flexibility and simplicity of the process are emphasized, especially for manipulating seasonal refinery butane balances. A maximum yield of highly unsaturated butane-butene can be recovered from naphtha polyforming with or without outside gas, or excess refinery butane-butene can be charged to the Polyform unit for maximum production of high-quality motor fuel. Extent of conversion of the outside-gas streams can be varied widely for optimum utilization of the available charge in the polyforming equipment.

The distillate produced by naphtha polyforming with or without outside gas is well balanced in volatility and can be used as a major constituent of motor fuel. Octane variation may be governed by the severity of cracking and the characteristics of the charge stock. Spread between A.S.T.M. and Research octane numbers vary with the A.S.T.M. rating of the finished product, and normally the spread trends to be greater for the more highly paraffinic naphtha stocks. Ordinarily the sensitivity ranges from 9 to 12 for polyform product of 76-77 A.S.T.M. octane number.

*Gulf Research and Development Co., Pittsburgh. †Process Engineering Department, Gulf Oil Corp., Pittsburgh.

GAS-CONDENSATE RESERVOIRS

. . . A Review

by O. F. Thornton

A.P.I.

Ten years of operation of gas-condensate reservoirs have verified the necessity and practicability of cooperative and unitized operation. Three types of gas condensates now are recognized: wet-gas; retrograde-gas; and reservoir-liquid. Operating method for each reservoir should be based upon characteristics of the gas condensate at reservoir conditions. Richness of the gas, size of reserve, capacities of wells, nature of reservoir, mode of occurrence of the gas condensate, and other factors must be considered. Many operators will be required to make a choice or compromise between complete pressure maintenance and gas sales. This can be done intelligently with known methods of evaluation. The author is associated with The Texas Co., Houston.

CONDENSATE differs markedly from conventional "crude oil." The color of crude oil is usually dark green or black; it feels oily when rubbed between the fingers; it contains some gasoline, but usually is made up in larger part of dark-colored, "heavy" nonvolatile components; its A.P.I. gravity, which is a measure of its weight or density, is commonly less than 45°. On the other hand, condensate is light-colored; it evaporates rather easily as compared with crude oil; it contains a large amount of gasoline and other volatile petroleum components; its A.P.I. gravity is above 50°.

Table 1 is a comparison of a typical condensate with a crude oil which brings out the differences discussed previously herein. Also shown is the amount of gas produced with each, expressed as cubic feet of gas per barrel of liquid. The gas-to-liquid ratios of wells producing gas condensate usually range from 10,000 to more than 100,000 cu. ft. per barrel. Gas is produced with crude oil usually in ratios of 100 to over 1,000 cu. ft. per barrel, or much less than with gas condensates. As will be discussed later, however, some wells produce gas condensate with ratios of less than 10,000 cu. ft. per barrel.

Now the most important property of condensate from the standpoint of operation of gas-condensate fields is this: The condensate can be "dissolved" entirely in the gas with which it is produced if the temperature is sufficiently high and if there is enough gas present. This fact is not surprising, because the condensate is light and volatile, as pointed out hereinbefore. Indeed, it is the reverse statement of the familiar phenomenon that a liquid can be condensed out by cooling or chilling many gases.

The temperatures in underground reservoirs containing gas condensate range from 100° to more than 250° F., as measured with thermometers lowered to the bottoms of wells. Similarly, pressures measured with recording gages lowered into the wells are from 1,000 to over 6,000 psi. These conditions are favorable for the gas-condensate mixture, to be completely in the gaseous state in the reservoir.

TABLE 1—COMPARISON OF CONDENSATE AND CRUDE OIL

	White gasoline	Gulf Coast condensate	Crude oil
Gravity, °A.P.I.	59	54.7	38.6
Color	Water white	Light straw	Dark green
Gasoline, per cent	100	70	31
Kerosene, per cent	...	16	16
Heavier than kerosene, per cent	...	14	53
Cubic feet of gas per barrel of liquid	Distilled from a crude oil	18,200	900

TABLE 2—COMPOSITIONS OF A RETROGRADE GAS AND A CRUDE-OIL-GAS MIXTURE

(All figures in mol. per cent)

	Retrograde gas			Crude-oil-gas-mixture		
	Gas	Condensate	Reservoir fluid	Gas	Oil	Reservoir fluid
Methane	91.32	....	87.07	92.80	....	57.83
Ethane	4.43	....	4.39	3.79	....	2.75
Propane	2.12	1.41	2.29	1.97	1.61	1.93
Butanes	1.36	5.71	1.74	0.96	2.24	1.60
Pentanes	0.42	8.11	0.83	0.28	2.45	1.15
Hexanes	0.15	10.46	0.60	0.13	3.47	1.59
Heptanes and heavier	0.20	74.31	3.08	0.07	90.23	33.15
Total	100.00	100.00	100.00	100.00	100.00	100.00
A.P.I. gravity of heptanes and heavier		51.2°			36.9°	
Molecular weight of heptanes and heavier		157			226	

Composition of Gas Condensate

Knowledge of the gas-liquid ratio and the gravity of the liquid is not sufficient to describe the composition of gas condensate for all purposes. Both the ratio and gravity of condensate depend upon the temperature and pressure at which the separation is made. Therefore, it is customary to express composition in terms of the percentage of each hydrocarbon in the gas, in the condensate, and in the gas-condensate mixture. These percentages are obtained by analyzing the gas and condensate produced, or by analysis of a sample taken at the bottom of a well. . . .

Percentage composition of both the gas and condensate portions of a typical gas condensate are shown in Table 2. Also, the analysis of the gas condensate as it existed in the reservoir is given. These analyses are compared with those of a crude-oil-gas mixture.

Main differences between the gas condensate and the crude-oil-gas mixture noted from Table 2 are: (1) The gas condensate contains relatively large amounts of methane and ethane, which are gases; (2) an appreciable portion of the condensate is composed of propane, butanes, and pentanes, whereas the crude oil is predominantly "heptanes and heavier"; (3) the characteristics of the heptanes and heavier in the condensate and in the crude oil are quite different. That of the crude oil is much heavier, as

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denoted by its low A.P.I. gravity and its high molecular weight. Propane, butanes, and pentanes are hydrocarbons which can be recovered and sold as liquids if the gas is processed through a plant, but which are not recovered efficiently by conventional separator operation. For this reason, it is usually desirable to consider recovery processes which are more efficient than ordinary low-pressure separators when operating gas-condensate reservoirs, in order to extract these hydrocarbons as liquids.

Wet Gases

The most familiar gas-condensate reservoirs are of what here will be called the "wet-gas" type. This name is adopted merely as a convenience to distinguish them from the other types of reservoirs discussed. Examples of wet-gas reservoirs are the Richland field of northern Louisiana and some of the Appalachian gas fields of the East. Very few of the recently discovered gas-condensate fields of the Gulf Coast are of this classification.

Gas produced from a wet-gas reservoir by a well can be passed through a separator operating at a temperature close to that of the atmosphere and a pressure of approximately 500 psi., and a condensate can be recovered. The liquid may be so small in amount that separators are not required; instead the liquid collects in "drips" installed in the flow line, and periodically is blown out. In some cases the quantity of liquefiable hydrocarbons is large enough to justify the construction of a large extraction plant.

As the gas is produced, pressure in the reservoir drops at a rate dependent on the rate of gas production and the producing capacities of the wells decline. The amount of liquid recoverable from each thousand cubic feet of produced gas, however, remains constant throughout the producing life of a field containing wet gas. The field is abandoned when the pressure in the reservoir has dropped to such a low value (usually less than 500 psi.) that the volume of gas and condensate which can be sold from each well is not sufficient to pay operating expenses. In some cases water encroaches into the reservoir and, therefore, the pressure is maintained at a high level. In this event, the field is abandoned when water has flooded out all the wells.

In Fig. 1 are shown typical performance characteristics of a hypothetical wet-gas reservoir. The decrease in reservoir pressure, and the constancy of the yield of condensate, will be noted. The distinguishing feature of wet-type gas-condensate reservoirs is this: The amount of recoverable liquid which is contained in each thousand cubic feet of the gas produced by the wells remains the same at all times. The percentage of the condensate and liquefiable hydrocarbons ultimately recovered from the reservoir, therefore, is equivalent to the percentage of the gas recovered.

It is possible to obtain a sample of the gas-condensate mixture as it exists in the reservoir by lowering a special container down into a well. By a suitable remotely controlled valve arrangement, the sample can be sealed in the container at the bottom of the well, so that the gas condensate does not escape when the "bottom-hole sample" is brought to the surface. Such a sample can then be taken into the laboratory and placed in a bath of the same temperature as that at the bottom of the well. By this means, the condition of the gas-condensate mixture as it existed in the reservoir can be observed. It is found that, in the case of wet-gas reservoirs, the gas condensate is completely in the gaseous state at reservoir conditions.

Removal of gas from the reservoir can be duplicated in the laboratory by opening a valve on the sample container and bleeding off the gas.[1] In the laboratory, as in the field, it is observed that the amount of condensate recoverable by cooling the "produced" gas to the temperature of the atmosphere in a separator remains constant at all times. No liquid drops out in the sample container, however, so long as the temperature is maintained at that of the reservoir. In this respect, the wet-gas type differs from a second class of gas-condensate reservoirs which will be discussed hereinafter.

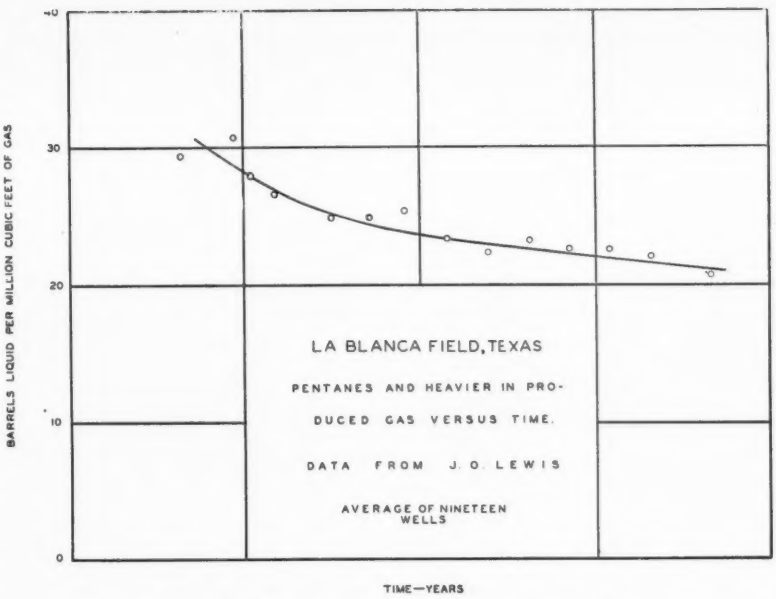

Fig. 2—Decline in condensate yield from a retrograde-type gas

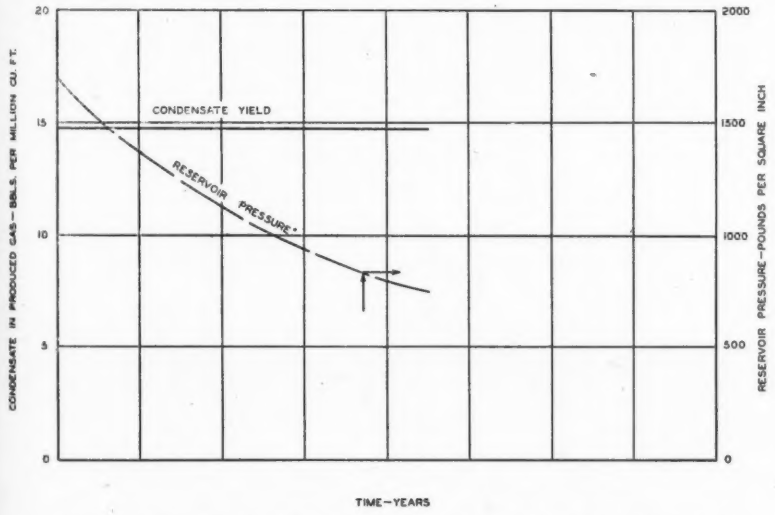

Fig. 1—Performance characteristics of reservoirs producing distillate-type gas

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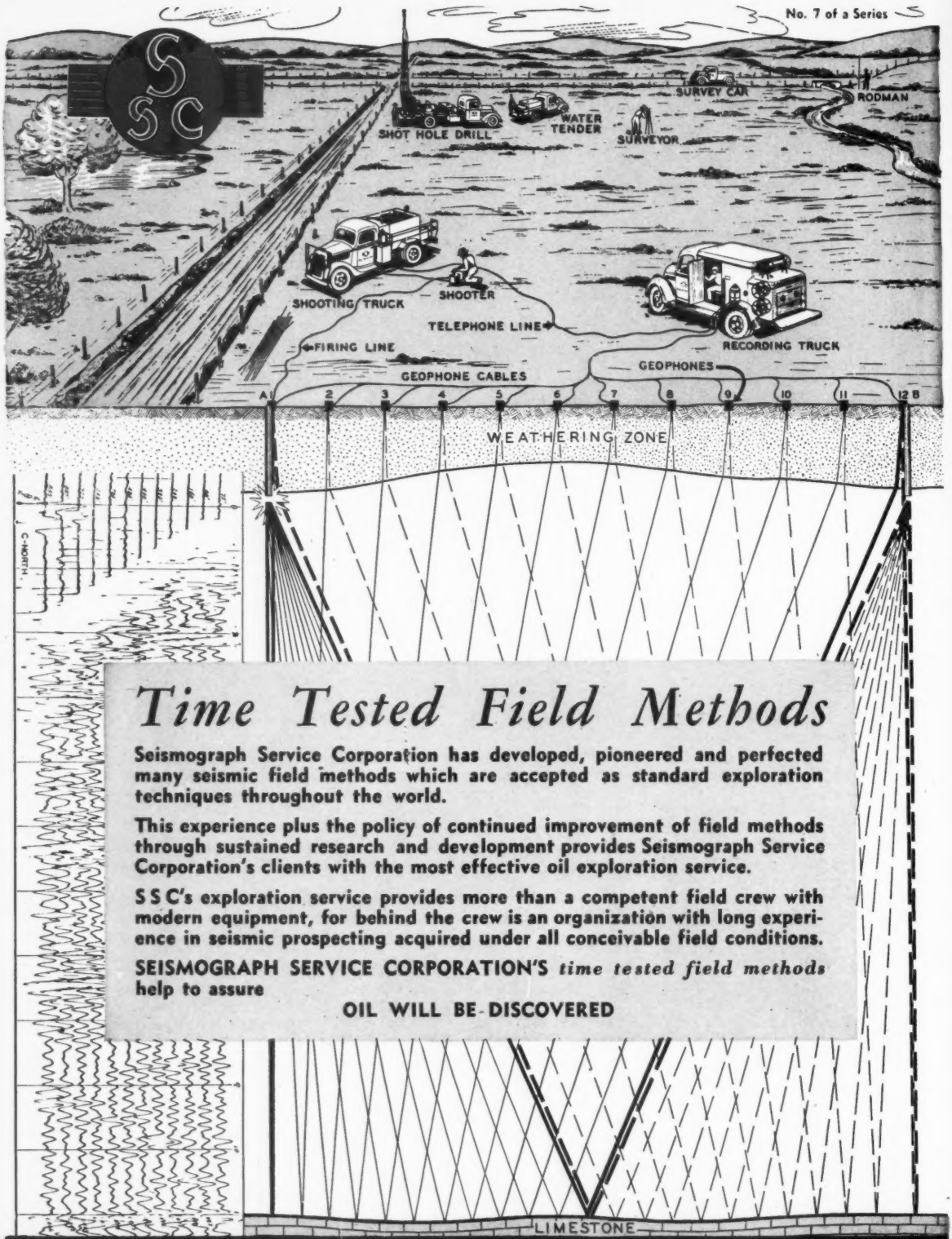

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Retrograde-Type Gases

Typical and well-advertised examples of the second type of gas-condensate reservoir are the Big Lake field, Reagan County, Texas,[3] and the La Blanca field, Hidalgo County, Texas.[3] Here, as in the case of the wet-gas class discussed hereinbefore, a liquid condensate was recovered by passing the gas produced by the wells through separators operating at atmospheric temperature. As the gas was produced, pressure in the reservoir dropped. However, in these cases it was observed that, as the pressure dropped, the yield of condensate from each thousand cubic feet of gas declined. In this latter respect it differed from the wet-gas type. Fig. 2 shows how the condensate in gas from 19 wells in the La Blanca field[3] declined from 31 bbl. of liquid (pentane and heavier) per million cubic feet of gas down to 22 bbl. per million in 3 years—a reduction of 29 per cent. Obviously, a considerable portion of the condensate remained in the reservoir and was not produced. The loss of this condensate was of sufficient magnitude to be of economic importance.

Again, an explanation of the observation made in the field can be obtained in the laboratory. A bottom-hole sample from the La Blanca well[4] was placed in a bath at reservoir temperature as previously described. The material was found to be entirely in the gaseous state. However, when removal of gas from the reservoir was simulated by dropping the pressure in the sample container held at reservoir temperature, it was observed that a liquid was condensed within the container.

A logical explanation of what happens in the field is apparent. When the pressure is dropped, due to withdrawal of gas, a liquid condenses in the reservoir. This liquid, composed largely of condensate otherwise recoverable at the surface, "wets the sand" and, therefore, cannot be produced by the wells.

This type of condensation, which is attributable to a drop in pressure while the temperature of the gas remains constant, is called "retrograde condensation." Similarly, the gas condensates, from which such condensation is observed at reservoir temperatures, are called herein "retrograde gases." Most of the gas-condensate reservoirs contain gases of this type.

It has been observed in laboratory tests that the amount of liquid which drops out by retrograde condensation is higher for rich gases, i.e., those from which large condensate yields are obtained. It has been estimated[1,5] that approximately 50 per cent of the recoverable liquid content of some gas condensates would be lost by retrograde condensation in the formation if the reservoir were produced and the pressure allowed to decline. In the case of "lean" retrograde gases, the loss would be less. The laboratory evaluation of the amount of possible retrograde loss, using bottom-hole samples made by combining surface gas and liquid, has been described in the literature.[1]

In order to reduce the loss due to retrograde condensation, the process called cycling (or recycling) has been developed. By this operation, gas condensation is produced from strategically located wells, the liquefiable hydrocarbons are removed, and the stripped gas, instead of being sold, is compressed and returned to the same reservoir from which it was produced through injection wells. These injection wells are also located strategically, and some distance from the producers. By injection of residue gas, pressure drop in the reservoir is prevented and, therefore, retrograde condensation is held to a minimum. Eventually, the injected "dry" gas displaces most of the "wet" gas between the injection and producing wells. These latter wells then begin to produce some of the dry gas, and the amount of wet gas produced begins to decrease. When the amount of dry gas becomes so large that the liquefiable hydrocarbons recovered from the small volume of wet gas will not pay operating expenses, the cycling process is abandoned. The gas in the field then can be sold, and reservoir pressure allowed to decline as in the case of the wet-gas type. It is estimated[6,7] that between 60 and 80 per cent of the condensate in a reservoir can be obtained by cycling. If cycling is followed by gas sales, the recovery may, of course, be increased—possibly to 80 to 90 per cent.

A map (Fig. 3) shows a typical arrangement of wells in a cycling project, with daily volumes produced and injected per well. Also the area occupied by dry gas at a particular time is designated to illustrate the mechanism of wet-gas displacement.

The area shown in Fig. 3 as being occupied by dry gas was determined by what is called a "model study" of the reservoir.[8] It can be shown that the flow of gas in a reservoir follows the same pattern as the flow of electricity in a conductive "model" of the field. These models are built to scale, and current is put in at points corresponding to injection-well locations, and current is taken out at producing wells. The amount of current per well is made proportional to the volume of gas produced by, or injected into, the well. By actual experience, it has been found that the dry-gas patterns determined by model study agree reasonably well with those obtained by observing dry gas encroachment into producing wells. Of course, the dimensions of and conditions in the reservoir must be accurately known, so that the model is an accurate picture of actual subsurface conditions. The use of electric models as guides by operators of cycling projects now is widespread.

Reservoir-Liquid Type

A few reservoirs recently have been discovered from which condensate and gas are produced, but the gas amounts to only 2,000 to 5,000 cu. ft. per barrel. This latter figure compares with over 10,000 cu. ft. from most other gas-condensate reservoirs. Bottom-hole samples from this third class of reservoirs have been studied, and it has been found that at reservoir conditions the gas condensate is not in the gaseous state, but is entirely a liquid.

The liquid produced from these reservoirs is similar to that from other

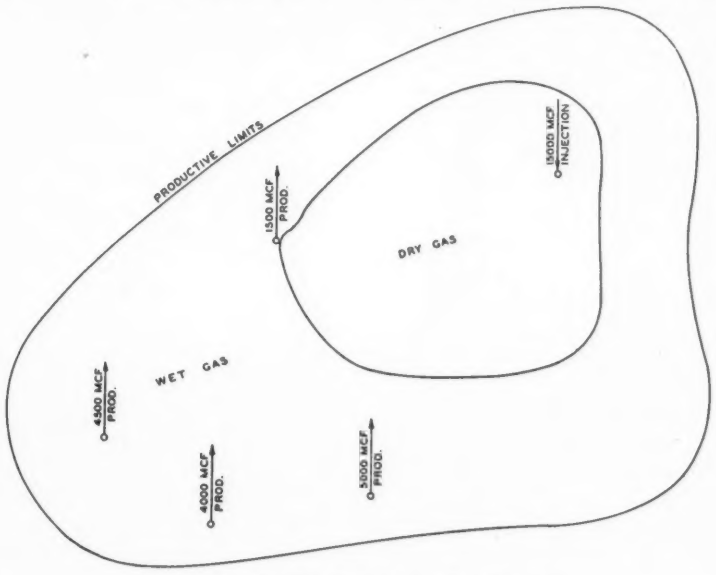


Fig. 3—Location of wells in a typical cycling plan

gas condensates. It is light straw in color, has a high A.P.I. gravity of more than 50° and is relatively volatile. If more gas is mixed with the condensate than was produced with it, say on the order of 10,000 cu. ft. per barrel—it can be observed in the laboratory that the mixture is entirely in a gaseous state at reservoir conditions of temperature and pressure.

The condensate from the "reservoir-liquid" type, therefore, has all the attributes of other condensates. However, the amount of gas present with the condensate in the reservoir is not sufficient to "dissolve" it. The mixture is in the liquid state at reservoir conditions. It is thus shown that the classification of a reservoir into one of the three types depends in part upon the amount of gas in the gas-condensate mixture.

Because the gas condensate is a liquid in the reservoir, it may be argued that such a mixture is truly a crude oil, that the operation of the reservoir should be the same as for a conventional oil reservoir. However, the losses which could result from such practices should be pointed out.

First, the loss of butanes, pentanes, and other light hydrocarbons due to conventional separator operation, as compared with plant processing, amounts to 10 to 25 per cent or more of the recoverable liquid in the gas condensate.

Second, the recovery from the reservoir by an operation wherein the reservoir pressure is not maintained will be very low—from 10 to 25 per cent of the amount originally in the reservoir. If pressure is maintained by gas injection, by water injection, or by restricting production to take advantage of natural water drive, the recovery can be increased to 40 to 70 per cent or higher.

Relation of Three Types

In discussing each of the three gas condensates, viz., the wet-gas, retrograde-gas, and reservoir-liquid types, it was desirable to describe the properties of the gas condensate in the laboratory under reservoir conditions of temperature and pressure. In order to point out the similarity between the three types, once again laboratory tests will be resorted to.

Assume that another bottom-hole sample of gas condensate is obtained. In the laboratory, it is observed to be entirely in a gaseous state at reservoir temperature and pressure. Now, instead of reducing pressure in the container by bleeding off gas, let the pressure drop be accomplished by expanding the size of the container. This may be done by a movable piston in one end of the container. Further, inasmuch as conditions can be varied at will in the laboratory, observations can be made at any desired temperature in addition to that of the reservoir. Therefore, the characteristics of gas condensate can be observed at many combinations of pressure and temperature.

The results of a number of such observations for a given gas condensate can be summarized as follows: At high temperatures, the mixture is entirely in the gaseous state or phase, and it remains gaseous at all pressures. This condition corresponds to the distillate-type gas. At slightly lower temperatures, the mixture is in the gas phase at high pressures, but, when the pressure is reduced, a liquid phase condenses. This corresponds to the retrograde-type gas. At still lower temperatures and high pressures, the mixture is entirely in a liquid phase. When the pressure is reduced, a gas phase forms; and two phases, viz., a liquid and a gas, are present. This corresponds to the reservoir-liquid type. Therefore, it is seen that the particular type of classification into which a gas condensate falls depends not only on the amount of gas in the gas condensate as discussed hereinbefore, but also on the temperature and pressure of the reservoir. The same gas-condensate mixture can be classed as any of the three types, dependent on conditions.

Fig. 4 is a picture of the previously given word summary, called a "phase diagram." There are three regions on this diagram: in one, the pressure and temperature are such that only a gas phase is present; at slightly lower temperatures and at intermediate pressures, both gas and liquid phases are present, i.e., a two-phase region; at lower temperatures and high pressures, only a liquid phase is present.

Assume that reservoir conditions of temperature and pressure correspond to the point P_1 in the diagram. The mixture is entirely in the gas phase. If, at the constant reservoir temperature, the pressure were dropped (as by production of gas from the reservoir), the corresponding path on the phase diagram would be a vertical line from P_1. It will be noted that such a line does not enter the two-phase region; mixture remains entirely a gas, or behaves as a wet gas.

If pressure-temperature conditions of the reservoir were equivalent to those designated by P_2, the mixture would be in a gaseous state. If, at the constant reservoir temperature, the pressure were dropped (as in the La Blanca field), a liquid would condense. This is shown in the phase diagram by the vertical line crossing into the two-phase region. Consequently, the mixture would be classed as a retrograde gas. The pressures at which the liquid first began to condense is called the "retrograde dew point." If the pressure were dropped to a very low value (an extension of the vertical line from P_2), the region wherein a gas phase only is present again would be entered. This means that the liquid which condensed as described would revaporize if pressure were reduced to a very low value.

In a similar manner, it will be noted that if the gas condensate is at a reservoir temperature and pressure corresponding to P_3, it is entirely in a liquid phase. A drop in pressure causes a gas to be liberated (two-phase region). The pressure at which a gas first forms is called the "bubble point."

It was stated previously herein that at certain conditions the gas condensate was entirely in a gas phase, whereas at others it was wholly a liquid. The question may be asked: "How is it determined that the mixture is a gas and not a liquid?"

At extremely high pressures of the reservoir, many familiar concepts of "liquids" and "gases" no longer apply. For instance, at 6,000 psi. gases are compressed to about one-fortieth of their volume at atmospheric pressure. A cubic foot of gas is reduced in volume to less than a 2-in. cube. At these high pressures, therefore, gases begin to react much like liquids. Con-

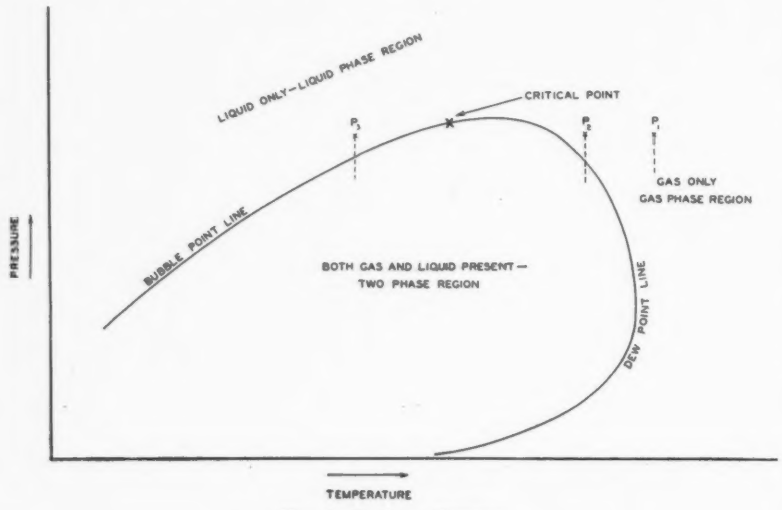
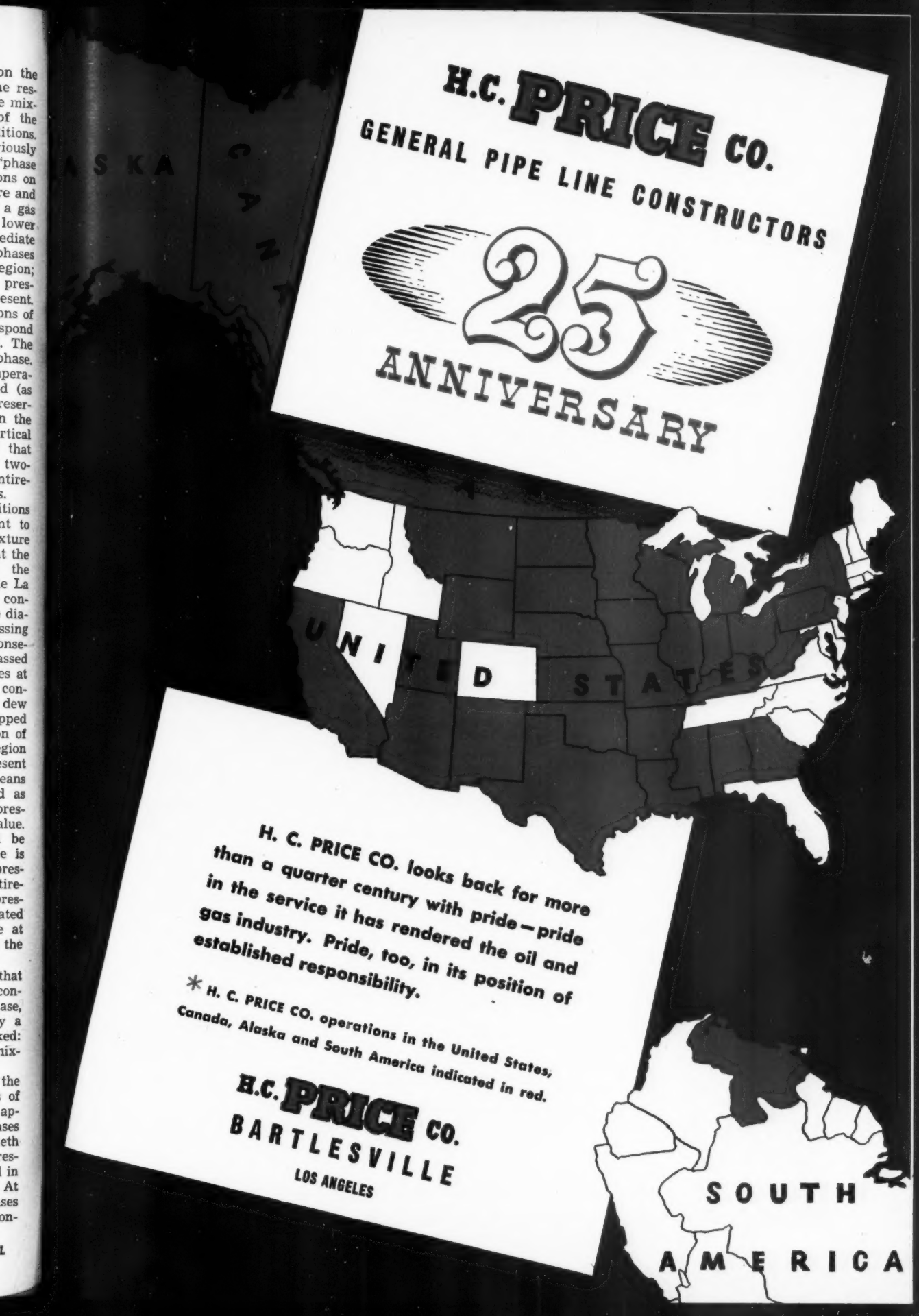


Fig. 4—A phase diagram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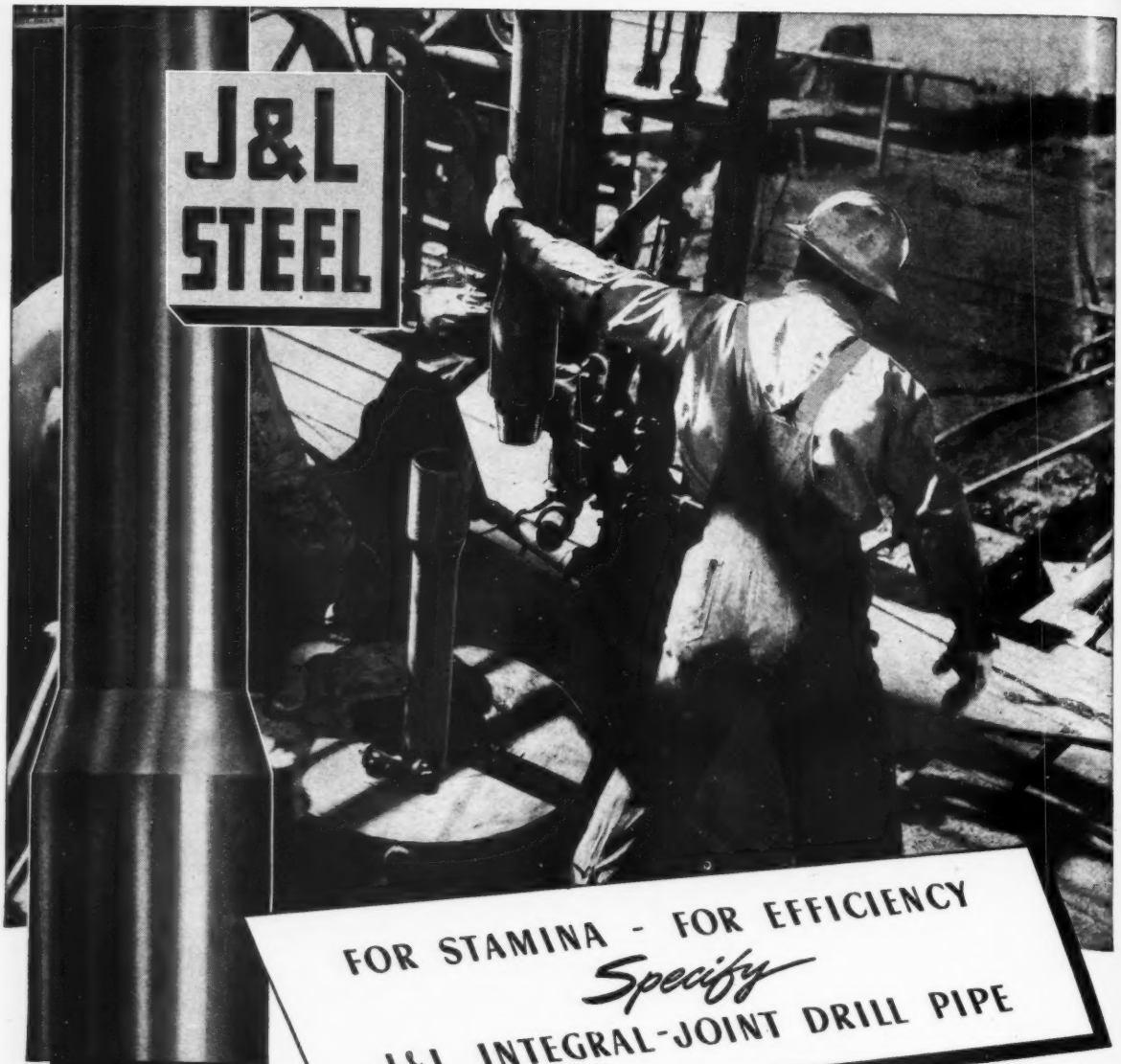

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versely, when as much as 2,000 to 5,000 cu. ft. of gas is mixed with a barrel of liquid (about 5 cu. ft.), the mixture begins to react much like a gas at high pressure.

As a matter of fact, there is one condition of temperature and pressure for each gas condensate, called the "critical point" (Fig. 4), where it is impossible to distinguish whether the gas condensate is a liquid or a gas. As this point is approached, the gas and liquid phase become identical in all characteristics.[7,9]

Rarely gas-condensate reservoirs have been discovered in which conditions are very close to the critical, but on the liquid side. In such cases, classification of the gas condensate is difficult, and operations should approach those for truly gas-phase reservoirs.

Table 3 gives data for three gas condensates and two crude oils, to illustrate each type of gas condensate discussed previously herein.

Occurrence With Oil Reservoirs

Wet and retrograde gases often occur as gas caps to crude-oil reservoirs. In some instances a retrograde gas cap and reservoir-liquid condensate are found in a common reservoir. The amount of oil present in such reservoirs has been found to vary considerably. It may be present only as a thin rim of liquid around the flanks of the structure, and may have no commercial significance—or oil may occupy in excess of 90 per cent of the pore space in the reservoir. The relative amounts of oil and gas condensate in such reservoirs have an important bearing upon the operating methods used, and upon the timing of recovery of the two reservoir fluids. In general, the practice has been to give primary consideration to recovery of oil, and recovery from the gas-condensate zone has often been deferred until exploitation of the oil zone was completed. If ownerships of the oil and gas condensate are diversified, some inequity of income at times may result in such cases.

Operating Methods

Basic principles governing best operating methods for gas-condensate reservoirs are not unique and, according to modern thought, are the same as for most oil reservoirs.[8] However, physical waste due to improper operation is both more serious and more easily discernible in the gas-condensate reservoirs and, therefore, the application of these basic principles has been more the rule than the exception. These principles are: (1) Selection of operating methods based upon the character of the reservoir fluids; (2) maintenance of pressure in those reservoirs where a decrease would result in loss of recovery underground; (3) efficient handling of produced fluids at the surface to obtain maximum liquid extraction; (4) optimum spacing of wells to obtain highest recovery; and (5) unitization of interests to assure equity to all parties having ownership in the common reservoir, and to enable application of principles (1), (2), (3), and (4).

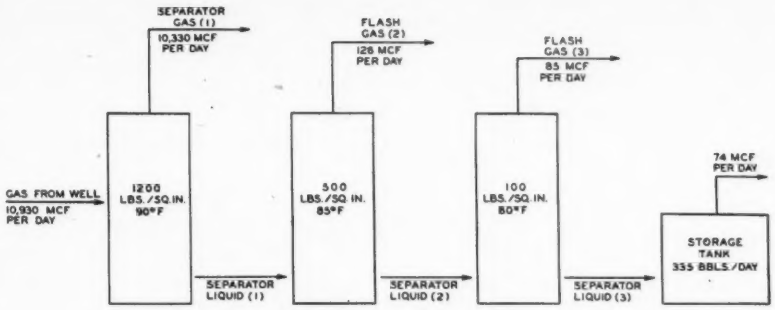

Fig. 5—Diagrammatic sketch of a multistage separation of gas condensate

Gas-condensate operations may be divided into two classes: (1) Those concerned with efficient recovery of gas condensate from the reservoir through the wells; and, (2) those pertaining to extraction of the liquefiable hydrocarbons from the well production. These two classes of operations are in many cases of equal importance. Inefficient extraction can result in losses as great as those due to retrograde condensation, or inefficient recovery.

The "cycling" operation previously described is now widely utilized for recovering retrograde gases. It is not necessary to cycle wet gases to prevent loss of condensate underground. Often, however, no market for gas exists, and by the cycling process the condensate can be recovered without awaiting the development of an adequate gas outlet. If the wet gas is the gas cap of an oil reservoir, cycling may enable the recovery of the condensate simultaneously with the oil. Production of the gas for sale obviously would cause oil to move into the gas zone, and result in significant loss of oil recovery. Hence some wet gases may be cycled.

Gas injection to maintain pressure and prevent retrograde condensation is not necessary if water encroaches into the reservoir as a retrograde gas is produced. In the case of wet-gas reservoirs, obviously the pressure need not be maintained, because no condensation takes place in the reservoir as pressure declines. In such cases, when there is a market for gas or when it may be utilized legally for some other purpose, gas-condensation reservoirs may not be cycled. Among other legal methods, in addition to gas sales for which gas has been utilized in such operations, are: injection into an oil reservoir to maintain reservoir pressure and so to increase oil recovery; injection into a gas reservoir of lower pressure for gas storage; and injection into a reservoir containing water for gas storage. The foregoing operating methods and others of similar nature, wherein the pressure in the gas-condensate reservoir is not maintained by residue-gas injection, may be called "gas sales or storage" to differentiate them from "cycling."

In the case of reservoir liquids, maintenance of reservoir pressure is essential. Injection of gas, injection of water, and restriction of producing rate to take full advantage of natural water drive are commonly applied for "pressure maintenance."

Methods of extracting condensate or other liquefiable hydrocarbons from the well production may be classed as: (1) Separation of gas and condensate in a conventional oil separator operating at approximately atmospheric temperature and a pressure ranging from 100 psi. to 500 psi. or more; (2) multistage separation as described hereinafter; and (3) extraction in a processing plant.

Recovery by a conventional separator is relatively low, ranging from 40 per cent or less to 85 per cent of that obtainable in a plant, depending upon the composition of the gas condensate. By multistage separation, recovery efficiency may be increased over that obtainable by use of one separator. Multistage separation (or simply stage separation) is illustrated diagrammatically in Fig. 5. Well production enters a separator operating at high pressure, on the order of 1,000

TABLE 3—COMPARISON OF GAS CONDENSATES WITH CRUDE-OIL-GAS MIXTURES

	A.P.I. gravity of liquid (deg.)	Gas liquid ratio (cu. ft. per bbl.)	Reservoir conditions		Retrograde dew point (psi.)	Bubble point (psi.)
			Temp. (°F.)	Pressure (psi.)		
Gas condensate:						
Wet gas	65	67,000	160	1,700	....	....
Retrograde gas	55	18,500	203	4,810	4,470	....
Reservoir liquid	58	2,700	203	4,700	....	3,855
Crude-oil-gas mixture:						
Mid-Continent	38	540	98	1,760	....	1,700
Gulf Coast	38	900	211	4,750	....	4,600

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TABLE 4—COMPARISON OF EXTRACTION METHODS

	Conventional separation	Multistage separation	Plant extraction
1. Barrels of liquid per M.M.c.f. of retrograde gas	52	58	70
2. A.P.I. gravity of recovered liquid, deg.	54.7	58.4	64.4

psi. The pressure selected usually is the one at which the separator gas retains the least amount of liquefiable hydrocarbons, or the "optimum separator pressure." Liquid from the first separator goes to a second separator at a lower pressure where additional gas is liberated, and so on through additional separators until atmospheric pressure is reached. The temperatures in each of the separators also may be controlled.

Plant processing is most efficient. Many of the plants in operation today of the absorption-oil type recover in excess of 30 per cent of the propane, 80 per cent of the butanes, and substantially all the pentanes, hexanes, and heptanes and heavier.

In Table 4 are given the barrels of liquid recoverable by each of the foregoing methods from one million cubic feet of a typical retrograde gas.

Summarizing the foregoing, present operating methods or those utilized in the past for gas-condensate reservoirs are combinations of: (1) Cycling; (2) gas sales or storage; or (3) pressure maintenance—with one of the three extraction methods, as indicated in Table 5.

TABLE 5—OPERATING METHODS—SUMMARY

Recovery methods:
1. Cycling
2. Gas sale or storage
3. Pressure maintenance

Extraction methods:
(a) Separator—conventional
(b) Separator—multistage
(c) Plant

Large volume gas markets have recently been developed on the Gulf Coast, and the possibility of chemical conversion of gas by the Fischer-Tropsch process into gasoline and other liquid hydrocarbons on a large scale promises to increase substantially gas sales over present volume. More and more operators will be required to choose between cycling with complete maintenance of pressure and gas sales.

Operating method used in a particular case depends upon the evaluation of a number of factors.[10] Obviously, the amount of recoverable liquid in the gas is very important. The cycling and plant processing of gas condensates containing less than 20 to 25 bbl. of liquid per million cubic feet usually is not financially attractive, unless there is a market for some of the residue gas from the plant. Also, the size of the reserve must be sufficient to pay out plant and well investments and to yield a reasonable return. Many small reservoirs, containing comparatively rich gas condensates, will not support a processing plant and pay out the cost of installing a compressor plant for cycling without some sale of gas concurrent with cycling.

The capacities of wells are an important factor. Low capacity means a large number of both producing and injection wells must be drilled, resulting in high investment costs.

Unitization

There is now almost universal agreement that unitization of operating and royalty interests is an essential prerequisite for efficient operation of a gas-condensate reservoir. The primary purpose of unitizing operations is to increase recovery of condensate and other liquefiable hydrocarbons, resulting in increased values to the operator, the royalty owner, and to society as a whole. In the foregoing sections of this review, unitization has been assumed in discussing operating methods.

Results of cycling operations have proved beyond doubt that the reservoir containing gas condensates is itself a unit, with no subsurface lease boundaries. The gas is freely migratory, and the amount of recovery from the reservoir is determined by the location of wells—not the number of wells. The operating method used is of primary importance, and it should be selected by study of the reservoir as a whole. . . .

A brief survey of differences between most oil and gas-condensate reservoirs may serve to clarify the more urgent need for unitized operation in the latter type of field. First, dollar recoveries per volume of the reservoir from gas condensate is much less than from oil. For instance, cycling yields on the order of 20 to 200 bbl. of condensate, and 1,000 to 4,000 M.c.f. of gas per acre-foot, worth approximately $65 to $470 at prices of $1.75 per barrel and $0.03 per M.c.f., respectively. On the other hand, crude-oil yields are on the order of 200 to 1,000 bbl. per acre-foot, with possible small additional value for gas produced with the oil. Whereas a profit can be made in most cases by drilling an oil well to each 40 acres, the same is not true of gas condensate. Wider spacing of wells means that a well cannot be drilled on each and every lease and, therefore, units must be formed to prevent gross inequity of income. Second, extraction plants to strip efficiently the liquefiable hydrocarbons from gas condensate require large investments in addition to that for drilling the wells, and it is not often that one operator in a field has sufficient holdings to make the construction and operation of such a plant financially attractive. Third, the actions of one operator in a field affect the operations of all others because of the freely migratory character of gas. This effect is more noticeable in gas-condensate than in oil fields. Thus, one operator by selling gas can (and in some cases has done so) drop the pressure throughout a reservoir containing retrograde gas or reservoir liquid, resulting in damage to any leases wherein operators are maintaining pressure by gas or water injection. . . .

Even when all parties interested in a given field have agreed that unitization is desirable, the agreement upon a basis for participation in a unit is often difficult. The basic principle for participation in most units has been[9,11] that each party should share in the unit in the proportion that the recoverable hydrocarbons under his tract, or the value thereof, bears to the total under all tracts. In largely undeveloped fields or those wherein sand conditions are uniform, surface acreage may be an equitable basis of participation. For fields wherein sufficient information is available, the amount of recoverable hydrocarbons can be calculated rather accurately. Net pay thickness, porosity, and water content of the pay are used to calculate the space containing hydrocarbons. The composition of the gas condensate is used to determine what portions of the reservoir fluid are recoverable as liquid and gas. Laboratory tests are made to determine the volume of reservoir space required to hold 1,000 cu. ft. of gas condensate—more commonly called the volume factor. By combining these factors, amount of gas and condensate under each tract can be computed.

References

1. E. W. McAllister, "Application of Laboratory Data on Phase Behavior to Evaluation of Condensate Reserves," Petroleum Engr. 17 (3) 90 (1945).
2. E. V. Foran, "Problems in High-Pressure Distillate Pools," Trans. A.I.M.E. 132, 22 (1939).
3. J. O. Lewis, "Interpretation of Well-Test Data in Gas-Condensate Fields," Petroleum Technology (T.P. 2053), July (1946).
4. F. V. L. Patten and D. C. Ivey, "Phase Equilibria in High-Pressure Condensate Wells," Oil Weekly 92 (1) 20 (1938).
5. E. V. Foran and P. C. Dixon, "Condensate Wells—Completion and Recycling Operations," Drilling and Petroleum Practice, 340-47 (1939).
6. H. H. Kaveler, "Cycling Operations," Oil Weekly, 123 (1) 33 (1946).
7. Emby Kaye, "Some Factors in the Economics of Recycling," Trans. A.I.M.E. 146, 221 (1942).
8. W. A. Hurst and G. M. McCarty, "The Application of Electrical Methods to the Study of Recycling Operations in Gas-Distillate Fields," Drilling and Production Practice, 228-40 (1941).
9. D. L. Katz and C. C. Singleterry, "Significance of the Critical Phenomena in Oil and Gas Production," Trans. A.I.M.E., 132, 103 (1939).
10. D. R. Knowlton, "Unitization — Its Progress and Future," Drilling and Production Practice, 630-34 (1939).
11. A.P.I. Special Study Committee on Well Spacing and Allocation of Production, Progress Report on Standards of Allocation of Oil Production Within Pools and Among Pools, 3 (1942).

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Reservoir Performance and Well Spacing

. . . Silica Arbuckle Pool, Kansas

by Lincoln F. Elkins

A.P.I.

The Silica Arbuckle pool of Kansas, producing from the Arbuckle dolomite by water drive, provides one case history for study of the recovery mechanism and for intrapool analysis of the recovery—well-spacing relation for this important type of petroleum reservoir. Pool performance to date indicates no substantial difference in ultimate recovery efficiency directly attributable to increased average well density within the range of 10 to 40 acres per well in this pool.

Tests in this pool show interference within a few hours between wells as much as 1,860 ft. apart. Disagreement between the theoretical pressure reductions in a homogeneous reservoir and those measured in the produced and shut-in wells suggests the presence of high permeability streaks comprising a relatively small fraction of the total pore space. It is hypothesized that the recovery mechanism for this type reservoir is primarily that encroaching water gradually displaces oil from the less permeable parts of the reservoir into these more permeable channels through which oil flows into the wells. With this mechanism, the number of wells penetrating the same system of extremely permeable streaks should not greatly influence recovery from that part of the reservoir in communication with these streaks. This is in agreement with the recovery—well-spacing relation indicated by the over-all performance of the Silica Arbuckle pool.

This paper is presented here in abridged form. The author is with Continental Oil Co., Ponca City, Okla.

OF the various oil-bearing formations in Kansas, the Arbuckle dolomite is the most important—both in cumulative past production and in current rate of production. The Silica Arbuckle pool, one of the larger pools in the state, is sufficiently depleted to permit estimations of ultimate recovery with reasonable accuracy. Inasmuch as it contains areas of different well spacing ranging from 10 to 40 acres per well, it provides a case history for analysis of the relation between well spacing and ultimate oil recovery for this important type of reservoir. In addition, many interference tests in the field provide information indicative of the oil-recovery mechanism. Oil and water production, potential, and allowable data from discovery to June 1, 1946, have been compiled. At that latter date the Silica Arbuckle pool was removed from proration by the Kansas Corporation Commission. The analyses thus cover the prorated portion of the pool life.

Geology

The Arbuckle dolomite of Kansas is equivalent to the Arbuckle sections of western Missouri and south-central Oklahoma. Oil reservoirs have usually been found in areas of high relief in the unconformity between top of Arbuckle and overlying beds. Using methods of correlation of acid-insoluble residue similar to those of McQueen,[1] Stanolind geologists[2] have identified at least five zones in the Arbuckle in Silica ranging up to 150 ft. in thickness. Individual wells, in general, probably penetrate only one zone, but the significance of presence of a number of zones is that various areas in the pool may perform somewhat independent of each other. A field test indicating this will be discussed later.

Structure of Arbuckle dolomite in the Silica pool is a long anticline with axis in a northeast-southwest direction. The highest part—in the central part of Area 4, Fig. 1—is at an elevation of about —1,490 ft. subsea level. Most producing wells except in the extreme east and west areas are within the —1,525 ft. level. Original water-oil contact was probably between —1,540 and 1,560 ft., but its exact location and uniformity are not known. Limited core analyses indicate an average of 7 per cent porosity and 60 md. permeability although individual cores run as high as 18 per cent porosity and 3,000 md. permeability.

Development, Well Spacing and Operation

The Silica Arbuckle pool was discovered in 1932 by three wells in 12-20s-11w, 9-20s-11w, and 31-19s-10w, respectively. Ellinwood area—Area 1, Fig. 1—was drilled on 40-acre spacing in 1933 and 1934. The Silica area —Area 4, Fig. 1—was drilled on a 10-acre spacing in 1935-1937. West Silica Area 3, Fig. 1, was drilled on a 13.3-acre spacing pattern in 1937-1940. In 1940 these were officially combined into the Silica Arbuckle pool. Area 1, Fig. 1, also known as West Silica, was drilled on a 20-acre spacing pattern, primarily in 1940 and 1941. Thus four main areas exist each of which had a different spacing pattern and a relatively short period of development.

Original pressure in the reservoir was about 1,050-1,100 psi. and the oil, for the most part, contained very little gas in solution. Practically all wells required pumping from the beginning. The reservoir has a very active water drive which has been almost the sole agent for oil displacement. By 1941 when some 25 million barrels of oil and a large amount of water had been produced, the pressure had declined only about 160 psi.

Early in the life of the field, allowable production was based on well potentials determined by physical test. This caused operators to install heavy-duty pumping equipment in order to obtain maximum allotment wells. High hourly rates during these tests and during regular production caused early encroachment of water. The method of measuring potential was changed to the less harmful drawdown test; also, many operators reduced the hourly fluid withdrawal rates. In many cases trends of increase in water percentage were lowered and lifting costs were reduced due to fewer mechanical difficulties. Data are not conclusive regarding effects of these reductions in withdrawal (i.e., lower pressure drawdowns) on the ultimate oil recovery or on the final cumulative water-oil ratio.

Many workover methods such as plugging back with cement or other materials, setting packers, and, more recently, injection of oil to depress water cones, have been tried to eliminate or reduce water production. Although each workover method has had some success, it is not yet possible to predict results. In general, the wells are produced until very high water percentages are reached and operations are no longer economical. Acidizing of wells is common both at initial completion and as a

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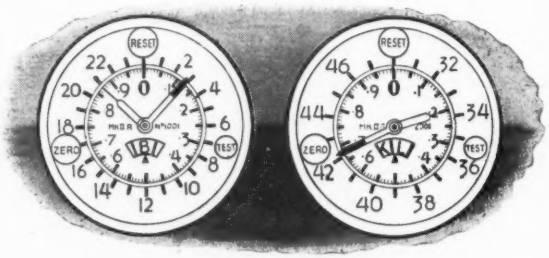

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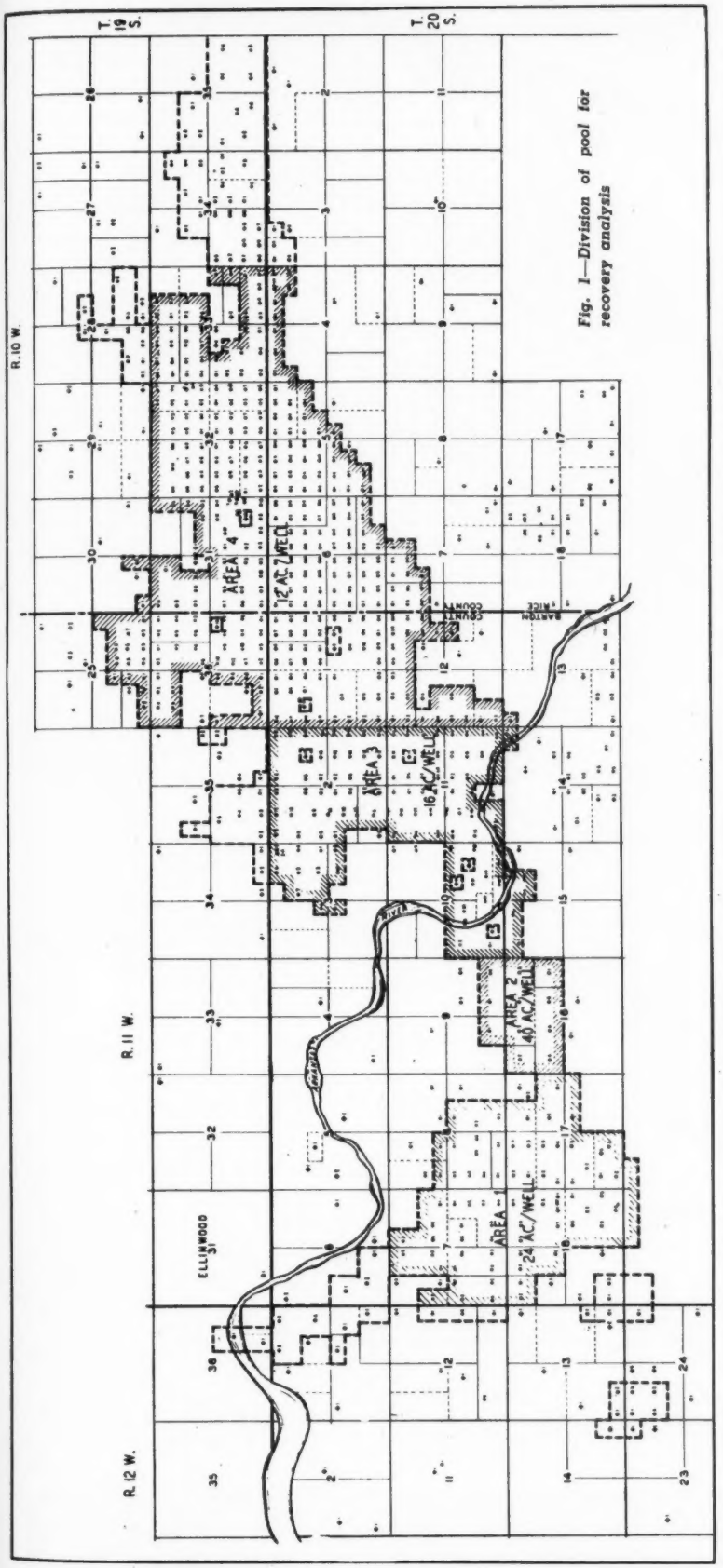

Fig. 1—Division of pool for recovery analysis

later workover method. Many new wells were acidized in order to obtain commercial production, and many were acidized to increase potentials in order to obtain higher allowables. Of the some 660 wells in the pool about 60 per cent were acidized upon completion.

Cumulative Oil Production—Effects of Proration

Cumulative oil production to June 1, 1946, was compiled by leases and allocated to quarter sections. Total for the area studied was about 54.5 million barrels. Highest recovery per acre to that date is along the crest of the structure in the area of 10-acre spacing—the area most nearly depleted. For a statistical comparison these data are plotted vs. average well spacing in Fig. 2. Even though there is considerable spread among recoveries per acre for any particular well spacing there is a definite trend of lower recoveries for the wider well spacing. However, before concluding that a similar trend will exist between ultimate recovery and well spacing, or that some physical factors in the reservoir affected by well spacing have been responsible for past performance, it is first necessary to determine what effect proration has had on recovery distribution. Cumulative production to June 1, 1946, for each lease in Areas 1, 2, 3, and 4 (Fig. 1) was divided by cumulative allowable to that date and plotted vs. well spacing in Fig. 3. Of 86 leases analyzed, 58 have a ratio of production to allowable between 0.9 and 1.1, 74 have a ratio between 0.0 and 1.1. Only seven leases failed to make 80 per cent of their allowable and the five listed as having made more than 110 per cent had production prior to January 1, 1935, the effective beginning of proration, so the production and allowable are not comparable.

This information indicates clearly that recovery to June 1, 1946 (the period of proration in the Silica pool), from the various areas has been only that allowed by the proration method. It can reflect effects of well spacing on recovery only if the proration formula properly accounts for all effects of reservoir factors (including well spacing) that influence oil-recovery efficiency.

In Kansas, allocation of production among pools is based on a law which says, in effect, that there shall be a straight line relation on log-log paper between average well potential of the various pools and the allowable percentage (i.e., that per cent of the potential which is allowed to be produced daily). Within each pool, allocation of production to each lease was obtained prior to December 1, 1939, by multiplying the allowable percentage by the total potential of all prorated wells and adding allowable of minimum wells. Since that date an

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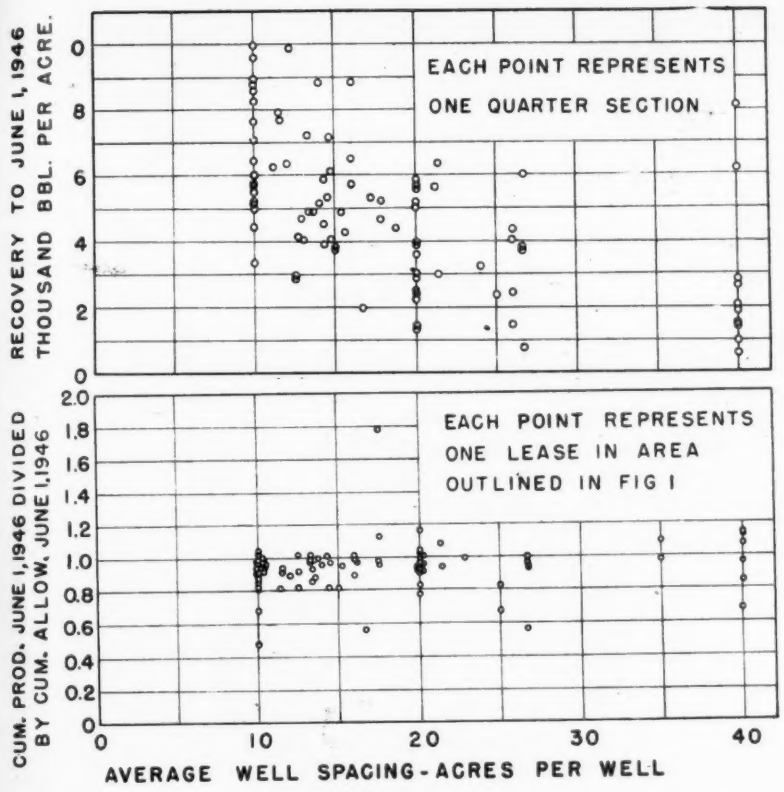

RECOVERY TO JUNE 1, 1946
THOUSAND BBL. PER ACRE.
EACH POINT REPRESENTS
ONE QUARTER SECTION
CUM. PROD. JUNE 1, 1946 DIVIDED
BY CUM. ALLOW. JUNE 1, 1946
EACH POINT REPRESENTS
ONE LEASE IN AREA
OUTLINED IN FIG 1
AVERAGE WELL SPACING - ACRES PER WELL

Fig. 2—(Top) Relation between recovery per acre to June 1, 1946, and well spacing in the Silica Arbuckle pool

Fig. 3—(Immediately above) Relation between cumulative production and cumulative allowable for leases of different well spacing in the Silica Arbuckle pool

acreage factor has been introduced so that wells on wider spacing (up to 30 acres credit at present) get a higher allowable than wells of similar potential on closer spacing. Thus up to December 1939, the well was the proration unit. Conditions were such that areas of close well spacing had the opportunity to recover oil at a faster rate than areas of wide well spacing; and, if reservoir conditions permitted, they also could drain oil from adjacent areas of wider well spacing.

Estimated Ultimate Recovery for Areas of Different Well Spacing

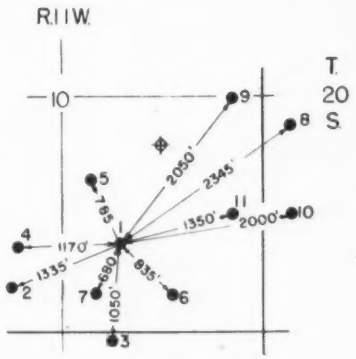
Recovery per acre to June 1, 1946, in the Silica Arbuckle pool gives appearance that large benefits in recovery efficiency can be obtained by close spacing of wells; however, inasmuch as the relation between recovery per acre to that date and spacing of wells has been found to be greatly affected by methods of proration, it does not necessarily follow that a similar relation will exist between ultimate recovery and well spacing. Only ultimate recovery per unit of reservoir voids, after correction for any regional migration of oil that may have occurred, can properly be used for a comparison of recovery efficiencies.

To approach such a comparison, four areas of different spacing of wells have been used. These are outlined in Fig. 1. . . .

Because of proration, the well potentials, rather than the actual production, have to be used as a measure of the producing ability of the wells. The potentials of all of the leases in each of the four areas were obtained . . . for the first of each year from 1941 through 1946, and for May 1, 1946 (the last month during which the Silica Arbuckle pool was prorated). . . . Average well potentials for each area were calculated by dividing the total potential by the total number of wells in each area that had been productive. Thus, abandoned wells were included as having zero potential. The average potentials were plotted vs. cumulative oil production for each area, and were extrapolated to estimate ultimate recovery. . . .

Similar plots of average potential vs. cumulative recovery were made for the group of leases in each area for which water-production data were available. The per cent oil in oil-plus-water production for each lease was then plotted against cumulative oil production on log-log paper and extrapolated . . . to estimate the ultimate oil recovery. . . .

Table 1 shows the essential data for these estimates. As an approximation, it was assumed that the same ratio of estimated ultimate recovery by extrapolation of oil percentage, di-



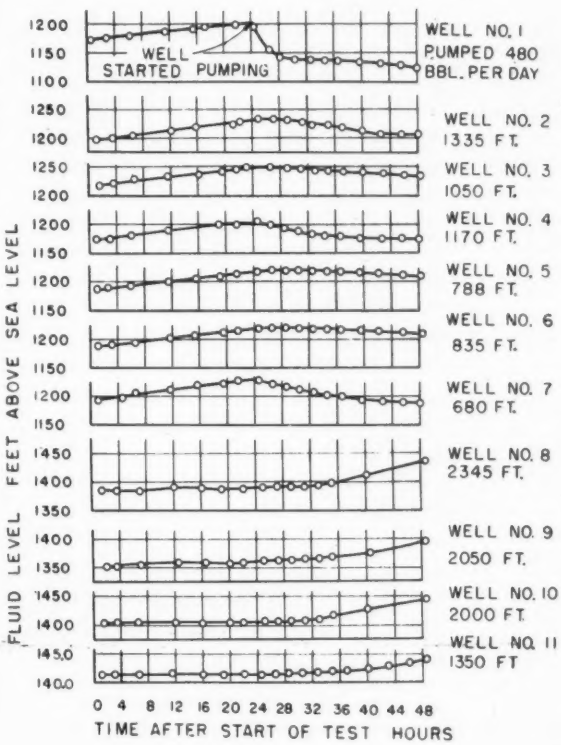


Fig. 4—Interference test No. 1 in the Silica Arbuckle pool

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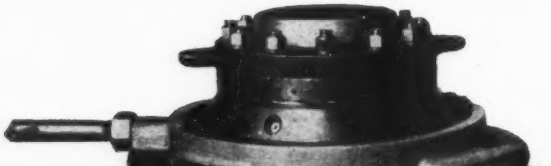

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TABLE 1—SUMMARY OF ESTIMATES OF ULTIMATE RECOVERY

Area	Acres	Average spacing, acres/well	Recovery to June 1, 1946 bbl./acre	Ultimate recovery estimated by decline in potential bbl./acre	Ultimate recovery estimated by decline in oil percentage bbl./acre
1	1,720	24	3,950	5,800	6,600
2	440	40	4,910	6,150	7,500
3	1,780	16	5,280	6,200	6,600
4	4,560	12	6,540	7,000	7,350

TABLE 2—RECOVERIES FOR COMBINED AREAS

Area	Acres	Average spacing acres per well	Ultimate recovery estimated by decline in potential bbl./acre	Ultimate recovery estimated by decline in oil percentage bbl./acre
1 and 2	2,160	26	5,900	6,800
3 and 4	6,340	13	6,800	7,150

vided by estimated ultimate recovery of potential decline, would hold for the entire areas as for the leases for which water production data were available. The per cent of total wells represented by the latter were 36, 100, 95, and 32, for Areas 1, 2, 3, and 4, respectively.

Although there is no way to be sure which is the more accurate method of estimating ultimate recovery—i.e., decline in potential or extrapolation of oil percentage—I believe extrapolation of oil percentage will more nearly represent future performance. The reason for this is that the water-production data for a pool represent well tests made about once a month, whereas the state potentials generally represent annual tests. During the war shortages of manpower and equipment caused many of the latter tests to be omitted; and the records show the same potential for some leases for periods as long as 2½ years.

If the oil percentage data in Table 1 are correct, they indicate that the parts of the field drilled first (Areas 2 and 4) will have the higher recoveries, whereas the parts drilled later (Areas 1 and 3) will have lower recoveries. This might indicate regional migration of oil between these two groups of areas. Field tests described in a later section herein indicate the presence of at least a partial barrier to flow in the reservoir in 10-20s-11w. This divides all of Area 4 and about 75 per cent of Area 3 (areas of closer well spacing) from Areas 1 and 2 (areas of wider well spacing). By combining Area 1 with Area 2, and Area 3 with Area 4, probable effects of regional migration of oil are eliminated, and a comparison between areas of quite different well spacing is still possible. The essential data are combined in Table 2. For these larger areas, ultimate recoveries per acre estimated by decline in potential are within 15 per cent, and ultimate recoveries estimated by extrapolation of oil percentage are within 5 per cent for a twofold range of well densities. . . .

A precise relation between well spacing and recovery efficiency is not determinable for the Silica Arbuckle pool, but these various calculations have indicated only a small percentage gain in average recovery efficiency attributable to increased well density within the range of 10 to 40 acres per well.

Effect of Potential on Individual Lease Recovery

Recoveries per acre to June 1, 1946 indicate at least qualitatively the relative ultimate recoveries per acre for nearby leases in the various parts of the pool. Variation among these at once raises the question whether the Arbuckle dolomite is uniform enough to make the results of the previous analyses significant, or whether they are coincidental. . . . In general, within each area, relative recoveries to date of the various quarter-sections are qualitatively in accord with initial potentials. Many of the exceptions are leases with high recoveries which were drilled earlier than adjoining leases. These probably gained ultimate recovery by early drainage across lease lines.

To investigate this more quantitatively, leases in that part of area 4 which is completely drilled on a uniform 10-acre spacing pattern were investigated in detail. Ultimate recoveries for each lease were estimated by extrapolation of average potential vs. cumulative recovery. . . . Because the estimated ultimate recovery ranges from 46,000 to 128,000 bbl. per well for the 25 leases studied, the relation between cumulative allowable to cumulative production was first compared. Of the 25 leases, 16 had ratios of cumulative production divided by cumulative allowable between 0.9 and 1.02; 22 had ratios between 0.83 and 1.02; and allowable data were incomplete for 2 leases. Thus the effect of potential in determining allowable (as all wells were on uniform spacing) appears to account for a great deal of the variance between leases.

As a further check, the ratio of estimated ultimate recovery to initial potential was calculated. A constant ratio of ultimate recovery to initial potential would be strongly presumptive evidence of inter-lease drainage, particularly inasmuch as more than half of the wells were acidized upon completion. . . . Many of the disparities between estimated ultimate recoveries are greatly reduced by this comparison. Some still existing are explainable by differences in time of development. . . .

This analysis is not proof, but it is quite indicative that many of the differences among recoveries of nearby leases resulted to a large degree from the potential effect in allocation of production, and not entirely from inherently large differences in the

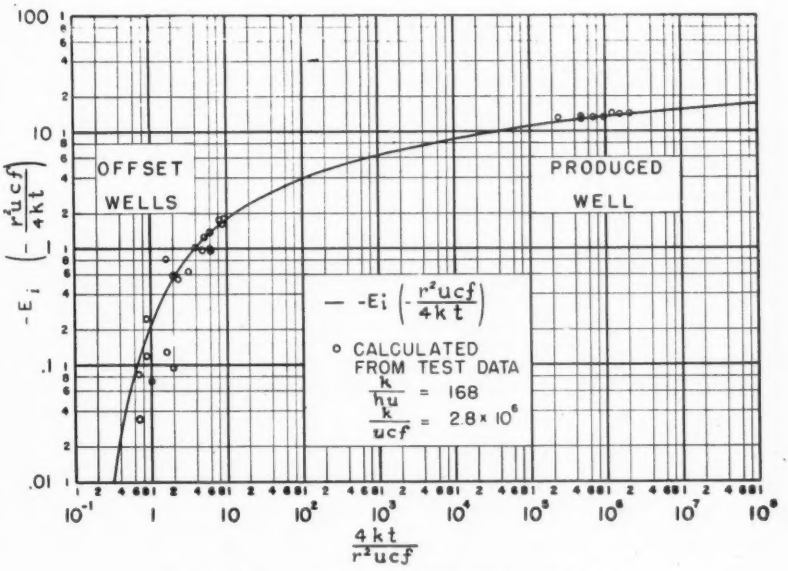

Fig. 5—Comparison of reservoir performance with theory—interference test in East Texas field

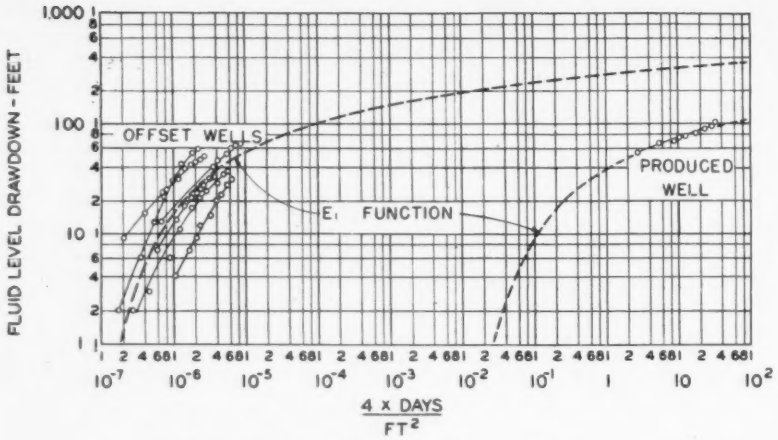

Fig. 6—Comparison of reservoir performance with theory. Interference test No. 1 in the Silica Arbuckle pool

quality of the Arbuckle dolomite as an oil reservoir. This, and the use of such large areas in the intrapool analyses (which tends to reduce effects of localized variations in reservoir character) make it appear that the relation between ultimate recoveries of areas of different well spacing in the Silica Arbuckle pool indicated by performance to date is more than coincidence.

Field Tests of Reservoir Performance

In many Arbuckle pools in Kansas, operation of wells has been observed to affect behavior of other wells. To determine this interference between wells more definitely, all wells in an area are shut in until substantially stable reservoir conditions are obtained. A central well is then produced, and fluid levels or subsurface pressures are measured in it and surrounding wells. Marked drawdown often occurs in shut-in wells within a few hours after the central well is started pumping at a rate not much higher than regular producing ratios. . . .

An example of an interference test is shown in Fig. 4. A change in trend of fluid levels was noted within 2 hours in wells up to 1,335 ft. from the produced well, which pumped 480 bbl. of oil per day. Of importance in this test is the difference between behavior of four wells northeast of the producing well and that of wells in other directions. A well farther east was shut down corresponding to 32 hours on the graph in Fig. 4, which accounts for further buildup in these four wells. Differences in fluid levels, buildup trends, and interference between these groups of wells suggest that they are producing from separate reservoirs. These results have been mentioned previously as an indication of a barrier to flow which may divide the Silica Arbuckle pool into at least two pools. Further evidence of this barrier is added by fluid-level measurements in other wells not included in this test. Although rate of fluid withdrawal during 1940 and 1941 in barrels per acre for 11-20s-11w (area directly east of this possible barrier) was more than 5 times as great as that for 9, 10, and 16-20s-11w (area west of the possible barrier), fluid levels in Section 11 were more than 300 ft. higher than those in the other areas. Pumps were set near bottom, and the wells were making little or no water; therefore, fluid levels should quite accurately reflect reservoir-pressure conditions. Higher pressure in an area of heavier withdrawals is not normally expected in continuous reservoirs with high effective permeability such as indicated by rapidity of interference between wells in this area. . . .

Interference or lack of interference between wells may be interpreted as a measure of the magnitude and extent of permeability of the producing formation. . . . Definite interference between wells shows at least a lower limit of drainage area of a producing well; but, of course, it does not by itself indicate drainage efficiency. Lack of interference in short tests such as these is not positive evidence of small drainage area.

Mathematical analysis of these data yields additional information regarding the reservoir characteristics. Using permeability calculated from pressure reduction and withdrawal rate in the produced well, and using reasonable values for porosity, oil viscosity, oil compressibility, and pay thickness, theoretical drawdowns in shut-in wells are calculated to be of the order of 1 ft. in 3 hours and 10 ft. in 24 hours after production of the central well has started. Actual fluid levels were lowered as much as 40 ft. and reductions from extrapolated fluid-level buildup were as high as 70 ft. in 24 hours. Compressible fluid-flow equations for radical flow in a homogeneous reservoir were used for calculation of theoretical fluid-level reduction. The relation for these conditions is[3]:

$$P = \frac{Q\,u}{4\pi kh}\,Ei\,\frac{(-r^2ucf)}{4\,kt}$$

Where:

p = pressure drawdown, psi.
Q = production rate, bbl. per day.
k = permeability, perms (1.127× darcys).
h = formation thickness,. ft.
c = compressibility of oil, volume per volume per psi.
f = porosity.
t = time, days.
u = oil viscosity, cp.
r = radius (from center of producing well), ft.

That such a relation is not too highly theoretical to apply to some naturally occurring formations is shown by results of an interference test in East Texas. Fig. 5 shows a comparison of theory and field measurements. Three tests at different rates were made; therefore, it was necessary to combine pressure drops, flow rates, and transmissibility and diffusivity constants for this comparison. The factor $\frac{k}{ucf}$ obtained from these test data agrees within 10 or 15 per cent of that calculated from core, electric-log, and subsurface - sample data of wells near the test area.

Inasmuch as static reservoir conditions had not been obtained before these tests were started in Silica, changes from extrapolated fluid-level buildup trends were used for comparison with theory. Fig. 6 shows plots of drawdown of fluid levels vs. the proper function of time and distance from the center of the producing well; 4-in. well radius was used for the producing well. The Ei function is shown passing through fluid-level data of the produced well, and also through data of offset wells, in positions that would be chosen based on either set of data alone. (Plotting these data on log-log paper, and shifting the Ei function always parallel to the axes, amounts to determining graphically the best values of $\frac{ucf}{k}$ and $\frac{u}{kb}$ by inspection.) The disagreement between theory and actual performance is in direction of too rapid and too large pressure reduction in shut-in offset wells. This disagreement suggests the presence of streaks of very high permeability comprising a small fraction of the total pore space. Within these short-period tests, pressure effects due to production could be transmitted through these streaks to large dis-

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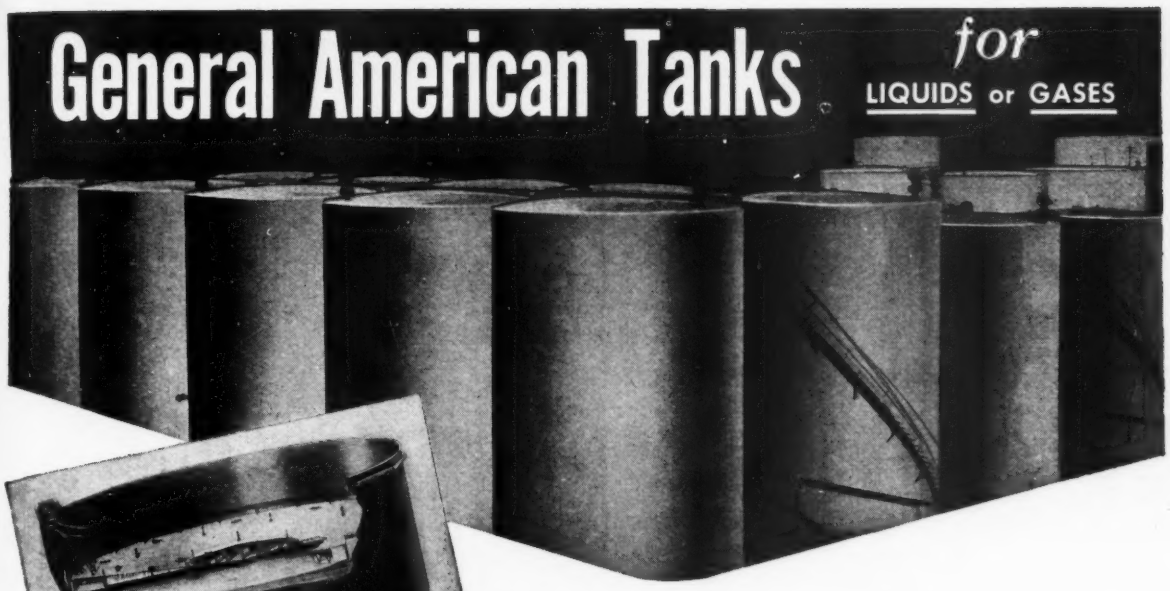

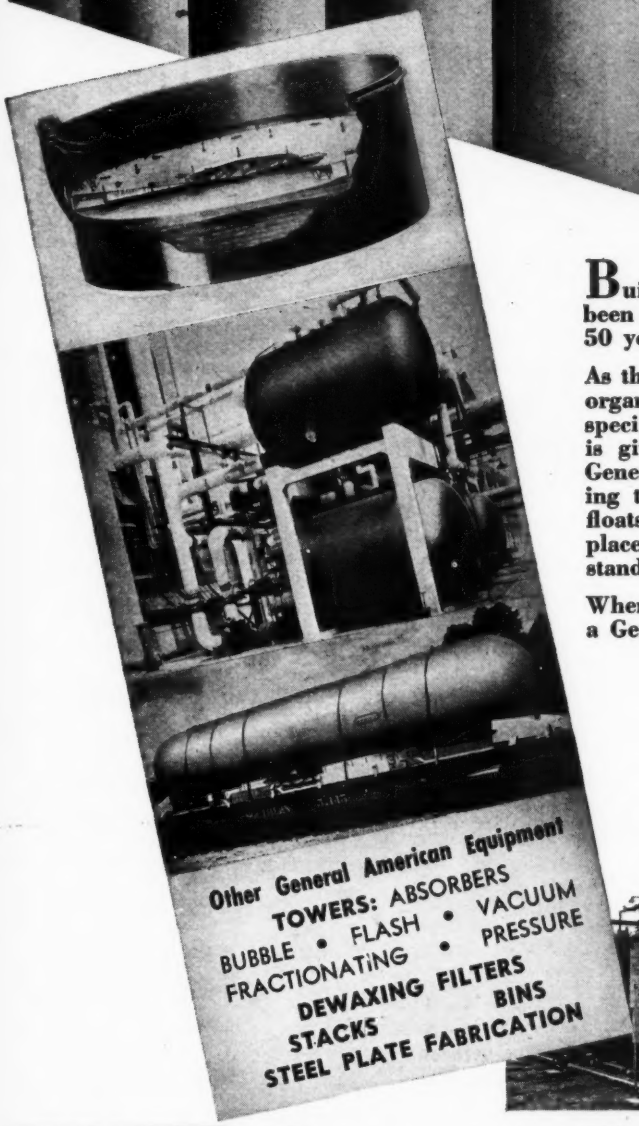

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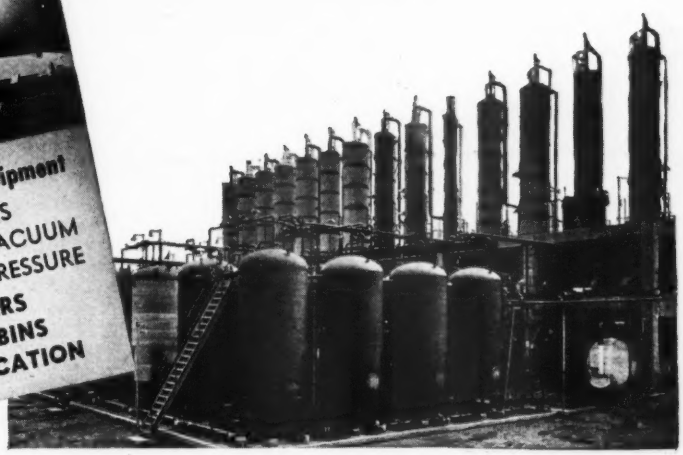

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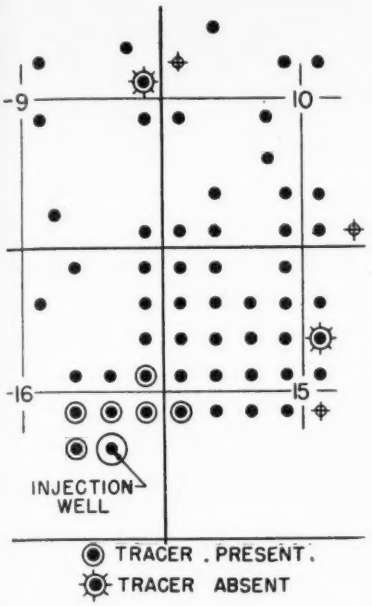

Fig. 7—Water-injection test, Kansas Arbuckle dolomite

tances before they were equally transmitted to fluid in all pore space in the intervening area.

A water-injection test in a nearby Arbuckle pool, where well interference similar to that in Silica has been observed, gave more direct proof of existence of these very permeable streaks. . . .

Water was injected into the top of Arbuckle dolomite in a well which had been temporarily abandoned. Location of wells is shown in Fig. 7. A tracer was noted in water produced by an offset well within 8 days during which 2,350 bbl. of water had been injected. It reached wells 1,500 ft. away when 3,800 bbl. had been injected. . . . Quantitative analysis for tracer showed that injected water comprised 20 to 50 per cent of water produced by three direct offset wells. Water injection was discontinued after 72,000 bbl., because it had no apparent effect on oil production of offset wells.

Assuming all injected water remained within the 140°-sector bounding input and producing wells, the 4,200 bbl. (average of two tests) injected before tracer reached wells at 1,500 ft. corresponds to a layer of water about 0.1 in. Considering that this lease had already recovered in excess of 5,600 bbl. of oil per acre, corresponding to a 9-in. layer, it is obvious that extremely low flooding efficiency was obtained. . . . Thin, highly permeable streaks appear to exist through which most of the water moved.

Significance of such very high-permeability streaks is that, although they contain only a small part of the reservoir oil, they comprise a large portion of the flow channels into many wells. Recovery efficiency appears to be a function of the water encroachment through the less permeable more massive rock, in which is stored the bulk of oil. Except for the possibility that these permeable streaks might dip below the water table, it would appear that extra wells penetrating the same system of very permeable streaks should not greatly increase oil recovery from that part of the reservoir encompassed by the streaks. Lack of measurable interference in some wells, presence of dry holes surrounded by producing wells, and low recoveries of certain wells indicate that some areas do exist where this condition of high permeability is not present; however, interference tests show that, in general, these individual systems of very permeable streaks do extend over areas many times the well spacing used in Silica. This hypothesis of recovery mechanism is in agreement with the relation between well spacing and recovery efficiency indicated by performance to date in the Silica Arbuckle pool.

Conclusions

These various analyses of recovery and performance of areas in the Silica

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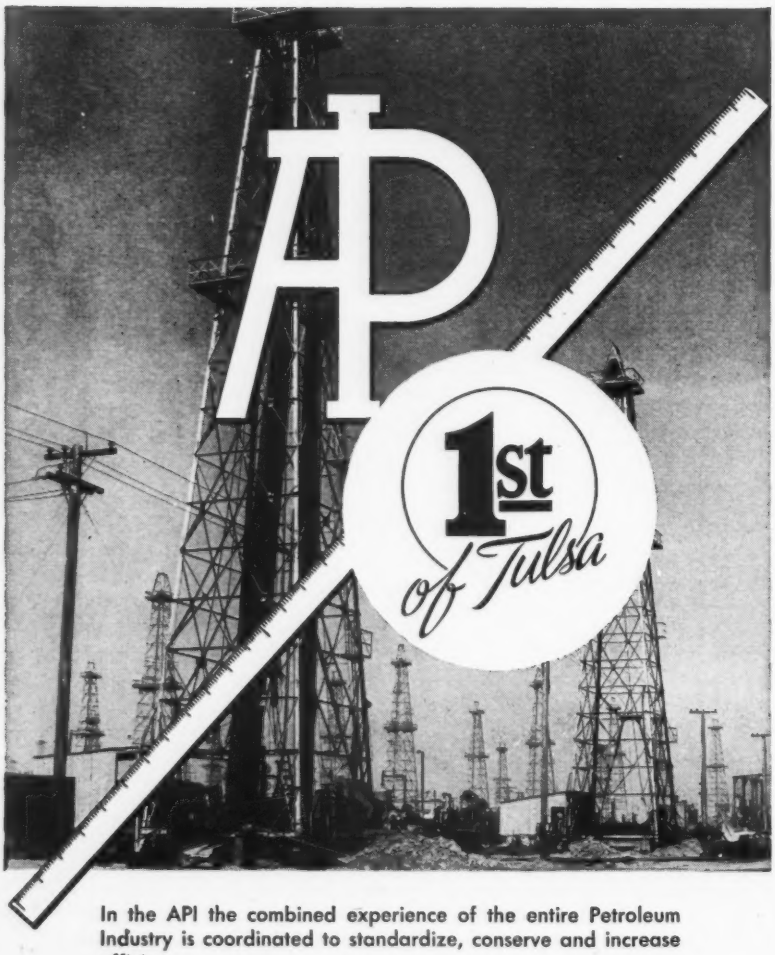

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Arbuckle pool drilled with widely different well spacing and of related field tests of reservoir behavior lead to the following conclusions:

Well performance in interference tests indicates the presence of extremely permeable streaks, comprising a small fraction of the reservoir volume—extending, in general, over areas many times the well spacing in the Silica Arbuckle pool. The dominant recovery mechanism appears to be displacement of oil from less permeable streaks by encroaching water into these more permeable streaks through which it flows to the wells. With this mechanism, recovery efficiency would not be expected to vary widely with average well spacing.

Performance of areas of different well spacing indicates no substantial difference in recovery efficiency directly attributable to increased average well density in this pool. This is in agreement with this recovery mechanism.

The method of proration based on well potentials has been responsible to a large degree for differences in recovery to date between nearby leases and between areas of different well spacing.

Acknowledgment

This study of the effect of well spacing upon reservoir performance in Kansas Arbuckle dolomite pools was carried on over a period of years while the author was a member of the consulting engineers' staff of Stanolind Oil & Gas Co. These data have been furnished by the consulting and production engineers' staffs of the Stanolind and by Gulf Oil Corp. The author wishes to extend herewith his grateful appreciation for this assistance, and for that of H. M. Northcutt for all the drafting. The conclusions arrived at herein are, however, those of the author.

Permission from Continental Oil Co. to publish this paper is hereby acknowledged.

References

1. H. S. McQueen, "Insoluble Residues—A Guide in Stratigraphic Studies," Missouri Bur. Geol. and Mines (1931).
2. A. R. Winzeler, "Progress Report: Insoluble Residues—Silica Area." Geol. Rpt. 514, Stanolind Oil & Gas Co., Jan 21. (1942).
3. M. Muskat, Flow of Homogeneous Fluids, 667. McGraw-Hill Book Co., New York (1937).
4. Oil - production orders and reports. Conservation Division of the Kansas State Corporation Commission.

Joe Bordman, geologist, has been placed in charge of a district office being opened by Pure Oil Co. in Durango, Colo.

Chester F. Barnes, formerly in charge of geological and geophysical exploration work for Cosden Petroleum Corp., Big Spring, Tex., has become a consulting geologist there.

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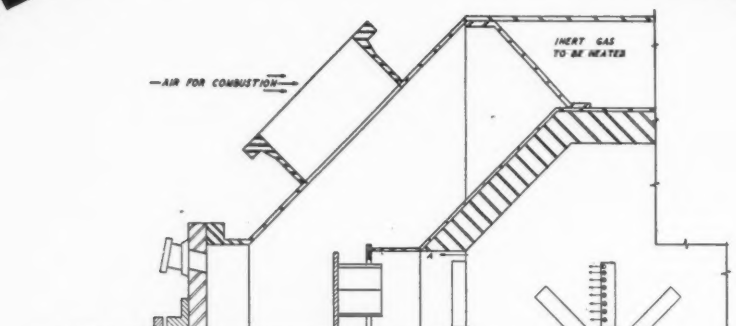

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Aviation Fuel Properties Varied by Alkylate-Hydropolymer Content

by H. W. Field and D. W. Gould**

THE blending of aviation gasoline during the early war years was characterized by many discrepancies. Two grades of combat fuel were required: one, for our own forces, AN-100, and the other for the British (BAM-100). The AN-100 specified only a single octane number, viz., the 1-C (later F-3); whereas the British Air Ministry (BAM-100) fuel specification carried, in addition to the lean-mixture octane value, a rich-mixture supercharged rating which was subsequently adopted by both allied air forces, and was approximately standardized as the 3-C (later F-4) rating. In blending to meet these two specifications, it was noticed that the preferred blending agent for meeting the BAM specifications was hydropolymer; whereas alkylate was as good, or possibly somewhat better, than hydropolymer for meeting the AN specifications. Yet, so far as our technology at that time was concerned, both types of plants produced "isooctane."

Alkylates Vs. Hydropolymer

Table 1 compares the analysis of a typical sulfuric-acid alkylate with that of a typical hydrogenated codimer from a phosphoric-acid catalyzed polymerization plant. The comparison is confined to trimethyl pentane (TMP) content and breakdown; but the chemical difference between the two blending agents was highly illuminating, and explained for the first time the difference in blending characteristics of the two materials. It was noted that predominant high-octane component of alkylate was 2,2,4-trimethyl pentane (isooctane); but the predominant component of hydropolymer was of a different chemical configuration, 2,3,4-trimethyl pentane, which, from the preceding tabulation, is seen to have a somewhat lower lean-mixture octane value (F-3), but is substantially better in rich-mixture value (F-4), than the 2,2,4-trimethyl pentane. In addition, the hydropolymer contains substantial quantities of 2,2,3-trimethyl pentane which is extremely good by both the F-3 and F-4 test methods.

A.P.I.

As an aside, it is interesting to note that production of 2,2,3-trimethyl pentane by the hydropolymer techniques was quite a challenge to the technologists engaged in developing alkylation processes, but up to the end of the war no data were submitted to the Technical Advisory Committee which showed alkylates with a greater 2,2,3-trimethyl pentane content than 4.0 per cent. Apparently, the mechanism of isobutane-butene alkylation produces this configuration only as an incidental byproduct. . . .

Sulfuric Vs. Hydrofluoric-Acid Alkylation

The first alkylation plants operated in this country used sulfuric acid as a catalyst; but, as the war program developed, alkylation plants using hydrofluoric-acid catalyst came on stream in increasing proportion. This was due largely to the self-contained feature of the HF plants in which catalyst regeneration was an inbuilt operation, which had appeal to refineries having no sulfuric-acid handling facilities in existence. In addition, these plants operated at higher reactor temperatures, requiring little or no refrigeration, which was attractive in view of the existing compressor shortage. In the early days of the war it was believed by most technologists that alkylation by either process accomplished essentially the same results; but, as the new plants went into operation, it soon became apparent that a somewhat different

TABLE 1—OPERATING CONDITIONS AND INSPECTIONS FOR PROJECT 6 ALKYLATES

	HF Alkylates*				
Type olefin feed—	C_3	C_3-C_4	C_4	C_4-C_5	C_5
Sample No.	17	16	13	15	14
Total feed, per cent by volume:					
C_3H_8	12.3	2.3	(0.9)	0.3	0.3
i-C_4H_{10} }	0.6	10.9	11.9	10.5	0.2
n-C_4H_{10} }					
i-C_5H_{12}	61.6	68.7	75.6	69.2	57.9
C_5H_{10}	...	†(0.8)	(0.6)	3.5	12.5
Volume ratio, i-C_4H_{10} per olefin:					
Internal	...	...	...	...	...
External	4.8	5.2	6.4	5.0	4.6
Per cent by volume of i-C_4H_{10} in reactor effluent	45.0	53.6	69.5	61.3	49.5
Temperature, °F.	101	100	100	99	102
Pressure, psi.	145	130	130	125	120
Residence time, min.†	24.5	25.0	24.5	20.4	23.4
Volume of acid per volume of hydrocarbon in reactor mixture	1.70	2.12	1.86	2.45	1.78
Acid strength, titratable acidity:					
Average	84	89	84	90	83
Fresh	85	91	90	95	90
Spent	80	87	80	87	75
Yields, volume per volume:					
Total alkylate per i-C_4H_{10} consumed	1.43	1.44	2.14	2.31	1.64
Total alkylate per olefin consumed	1.67	1.85	1.32	1.28	1.67
Light alkylate per total alkylate	94.6	92.8	93.8	93.2	96.2
Pentane-synthesized, per cent by volume of depentanized total alkylate	...	...	...	4.0	7.0
A.S.T.M. octane No.:					
Without addition of TEL	87.5	87.9	91.1	88.6	87.1
F-3 with addition of 4 ml. TEL per gallon	102.7	102.5	105.2	102.9	102.5
F-4 with addition of 4 ml. TEL per gallon	1.12	1.10	1.77	1.08	0.80
Index	127	127	138	127	121

*Catalyst-depletion operation. †Volume hydrocarbon in reactor divided by total charge rate. ‡Figures in parenthesis are approximate.

*The Atlantic Refining Co., Philadelphia, (formerly members of TAC Synthesis Subcommittee of the Petroleum Industry War Council). Condensed from "Project 6 Spotlights Avgas Progress," presented to Division of Refining Group Session on Gasoline, before twenty-sixth annual meeting of the American Petroleum Institute, in Stevens Hotel, Chicago, November 12, 1946.

TABLE 2—OPERATING CONDITIONS AND INSPECTIONS FOR PROJECT 6 HYDROCODIMERS

Sample No.	4	33	44	36	37	41	42	35
Catalyst	Phosphoric-acid							H_2SO_4
Process	UOP	UOP	UOP	UOP	UOP	Polyco	Polyco	Shell
Reactor type	Tubular	Tubular	Tubular	Tubular	Chamber	Tubular	Tubular	Hot-Acid
Feed analysis, per cent by volume:								
C_3H_6	....	....	1.0	....	3.1	0.1	....	....
i-C_4H_8	....	....	17.0	12.2	13.9	11.9	11.4	14.0
n-C_4H_8	....	....	7.2	22.7	21.5	32.6	33.5	28.5
C_5H_{10}	....	....	....	1.6	....	1.3	1.6	3.0
Recycle ratio*	....	1.1	0	0.20	1.02	0.81	0.81	....
Space velocity	....	0.51	0.72	0.39	0.14	0.26	0.26	†5.5-6.5
Inlet temperature, °F.	....	278	308	340	257	286	337	....
Outlet temperature, °F.	....	290	324	345	306			....
Pressure, psi.	....	600	800	600	700	900	900	170
Absorber temperature, °F.	....	....	....	....	....	....	....	176
Catalyst age, gal. per lb.	....	....	....	....	....	....	....	‡1.8
Olefin conversion, per cent	....	54	92.8	78.7	71.8	60.5	86.2	38.3
Reaction ratio	....	1.8	1.41	2.34	1.68	2.41	3.61	1.45
Acid strength	....	....	....	....	....	....	....	7.0
A.S.T.M. octane No. for hydropolymer:								
Without addition of TEL	93.8	....	95.0	92.0	89.5	92.5	91.0	....
F-3 with addition of 4 ml. TEL per gal.	103.2	....	§(107.5)	104.0	103.4	104.5	103.6	....
F-4 with addition of 4 ml. TEL per gal.	177	....	133	155	104	162	148	....

*Reaction ratio $= \frac{\text{total olefins converted}}{\text{isobutylene converted}}$. †Contact time, in minutes. ‡Pounds of acid per barrel of polymer. §Data in parenthesis approximated.

chemistry was involved using the two different catalysts, as octane values obtained on HF alkylates were at variance with previous experience on sulfuric-acid alkylates.

The analysis shown in Table 2 gave the first picture of the fundamental difference between HF and sulfuric-acid alkylation. From this tabulation it can be seen that an HF alkylation plant had to run at lower effective capacity (higher isobutane in reactor effluent) in order to equal the sulfuric-acid plant in F-3 octane quality; and, even then, it fell somewhat short in quality on an F-4 basis. A glance at the trimethyl pentanes distribution in the alkylates gives the reason for this difference.

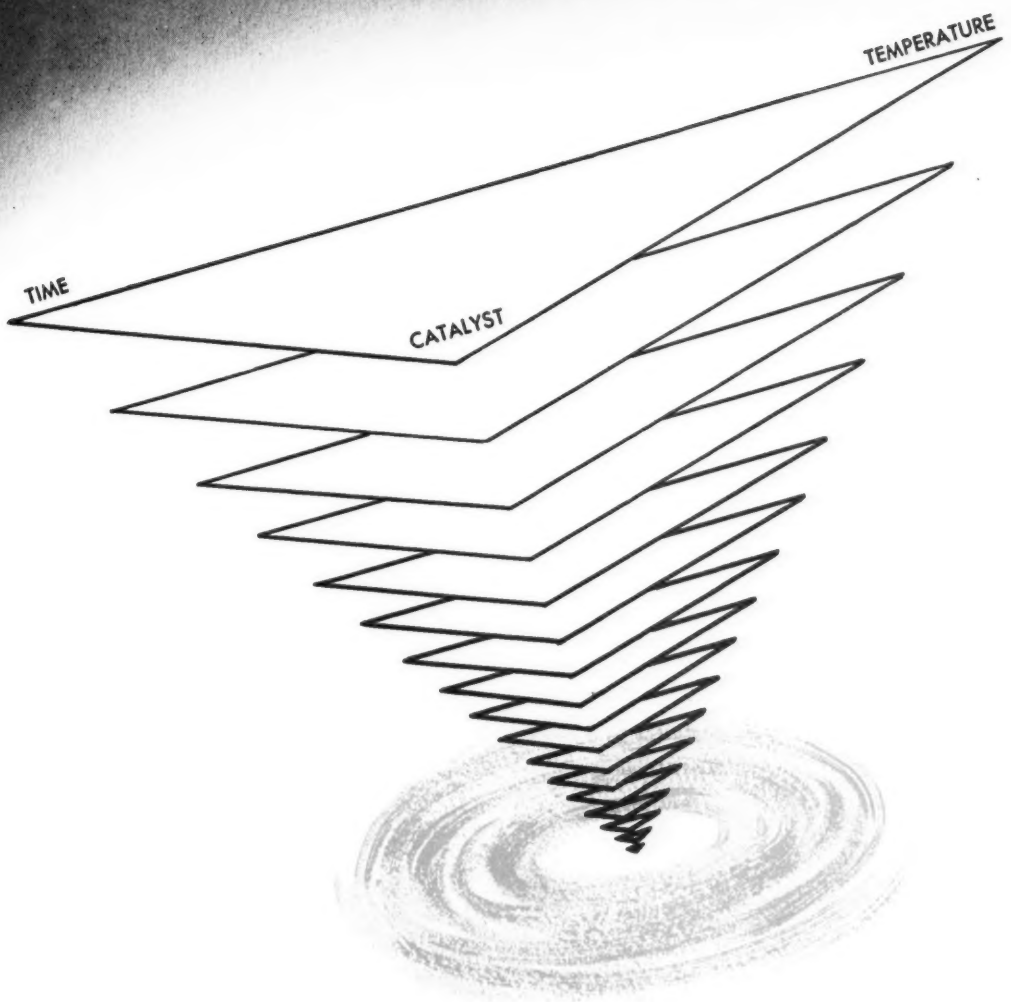
These analyses indicated, and subsequent work confirmed, that HF alkylation is a "purer" alkylation in that the production of the 2,2,4-trimethyl pentane is more predominant

TABLE 3—DETONATION PROPERTIES OF HYDROCARBONS

Hydrocarbon—	Point boiling (°F.)	A.S.T.M. Oct. No. (without addition of TEL)	1-C blend Oct. No. (with addition of 4 ml. TEL per gal.)	3-C blending index No.
Isopentane	82.2	90.3	110	142
Normal pentane	97.0	61.9	87	2
Cyclopentane	120.7	85.0	102	315
Olefins	<96.8	*80	*85	*100
2,2-Dimethyl butane	121.5	93.4	111	152
2,3-Dimethyl butane	136.4	94.3	111	205
Olefins	120-145	*80	*85	*100
2-Methyl pentane	140.5	73.5	96	66
3-Methyl pentane	145.9	74.3	96	66
n-Hexane	155.7	26.0	65	—100
Olefins	145-162	*80	*85	*100
Methyl cyclopentane	161.2	80.0	100	200
2,2-Dimethyl pentane	174.6	*93	100	143
2,4-Dimethyl pentane	176.9	83.8	100	83
Benzene	176.1	113.6	97	220
Cyclohexane	177.3	77.2	90	188
Olefins	162-194	....	....	....
2,3-Dimethyl pentane	193.6	*89	100	143
2-Methyl hexane	194.2	45	*73	*90
3-Methyl hexane	197.6	*55	*79	*80
1,1-Dimethyl cyclopentane	189.1			
Trans-1,3-dimethyl cyclopentane	195.4	76.9	*94	*125
Trans-1,2-dimethyl cyclopentane	197.4			
Olefins	194-203	*80	*85	*85
n-Heptane	209.1	0	52	—200
2,2,4-Trimethyl pentane	210.6	100	113.4	154
Methyl cyclohexane	213.6	71.1	89	120
Olefins	203-214	*80	*85	*60
Paraffins	223-253	*75	*92	*100
2,2-Dimethyl hexane	224.2	77.4	*101	*120
2,5-Dimethyl hexane	228.4	55.7	80	44
2,4-Dimethyl hexane	228.9	69.9	*94	*80
2,3-Dimethyl hexane	240.1	78.9	*99	102
3,3-Dimethyl hexane	233.6	83.4	*100	*102
Naphthenes	217-237	*70	*89	§115
Toluene	231.1	104.2	*98	250
2,2,3-Trimethyl pentane	229.7	99.9	114	238
2,3,4-Trimethyl pentane	236.3	95.9	108	193
2,3,3-Trimethyl pentane	238.6	99.4	112	234
Isoparaffins	239-253	*55	*80	*95
Naphthenes	243-255	*65	*83	*105
Olefins	214-257	*67	*77	*—100
2,2,5-Trimethyl hexane	255.4	91.4	108	*150
2,3,5-Trimethyl hexane	268.5	*85	*104	*120
n-Octane	258.3	*—20	*35	*—220
Isoparaffins	259-284	*75.7	*93	*100
Isoparaffins	284-318	*35	*67	*100
Isoparaffins	289-304	*25	*63	*80
Isoparaffins	304-320	....	....	....
Isoparaffins	318-352	....	*60	*60
Isoparaffins	>320	....	*60	*60
Isoparaffins	>352	....	*60	*60
Naphthenes	261-298	*57	*76	*0
Ethyl benzene	277.2	97.9	102	250
p-Xylene	281.1	103.5	105	265
m-Xylene	282.4	103.4	105	265
o-Xylene	291.9	100.0	85	—15
Olefins	257-298			
Naphthenes	>253	*55	*74	*30
Paraffins	>253	*65	*86	*180
Aromatics	>293	*99	*103	*240
Olefins	>96.8	*92	*98	*130
Naphthenes	>298	*50	*69	*—20
Paraffins	>298	*65	*86	*100
Aromatics	>298	*98	*102	*220
Olefins	>298	*80	*85	*—120

*Ratings are assumed.

fluid catalytic cracking



The drawing-together of three basic factors—
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TABLE 4—PROPENE ALKYLATE

Sample No.	9	20	17
Catalyst	H_2SO_4	H_2SO_4	HF
Olefin:	C_4	C_3	C_3
2,2,4-TMP, per cent	25.9	7.8	16.3
2,2,3-TMP, per cent	1.7	0.8	1.1
2,3,4-TMP, per cent	16.4	2.5	3.4
2,3,3-TMP, per cent	12.1	3.2	3.9
Total TMP's	56.1	14.3	24.7
Octane No.:			
F-3 (4 ml. TEL)	104.3	103.3	102.7
F-4 (perf. index)	142	129	127
Temp., °F.	45	60	101
Per cent i-C_4 (in reactor effluent)	45.7	69.7	45.0
2,4-DMP, per cent	4.2	26.2	18.2
2,3-DMP, per cent	2.1	36.1	21.1
Total DMP's	6.3	62.3	39.3

TABLE 5—POLYMER ALKYLATION (H_2SO_4)

Sample No.	10	21	43	34	24
		Trimer hot acid	Trimer cold acid	Dimer hot acid	
Olefin feed:	C_4				C_4
2,2,4-TMP, per cent	26.8	30.5	31.4	35.6	35.5
2,2,3-TMP, per cent	1.6	2.5	1.1	1.8	2.0
2,3,4-TMP, per cent	19.2	10.4	14.9	15.7	24.0
2,3,3-TMP, per cent	14.9	11.9	12.5	16.9	25.2
Total TMP's	62.5	55.3	59.9	70.0	86.7
Octane No.:					
F-3 (4 ml. TEL)	105.6	105.4	105.8	108.1	108
F-4 (perf. index)	143	149	150	154	179
Temp., °F.	45	50	48	50	39
Per cent i-C_4 (in reactor effluent)	59.0	64.1	78.0	72.0	81.3
Spent acid, per cent	90	90	90	90	94.6

than in sulfuric-acid alkylation. Chemically, this characterizes HF as a better alkylation catalyst; but, from the standpoint of F-4 octane requirements, which were chronically critical throughout most of the war years, the HF plants were slightly disappointing in their response to increased throughputs in isobutane-butene alkylation. . . .

Marginal Olefin Alkylation

As the aviation-gasoline program expanded and new facilities were put into operation, the light hydrocarbon balance in most refineries wandered quite far from the original design plans. . . . Some sulfuric-acid plants started charging pentanes as marginal olefin feed with considerable success—showing little, if any, drop in alkylate quality. Other sulfuric-acid plants reported very poor results, particularly from the standpoint of the rich-mixture quality (F-4) of their production. The analyses of samples of alkylates from the various plants involved in these apparent discrepancies were illuminating, and paved the way to an ultimate understanding of the mechanism of pentenes alkylation. In Table 3, Samples 9 and 7 show the effect of introducing full boiling-range pentenes into an alkylation plant as additional olefin feed. A drop in alkylate quality is noted particularly in the F-4 value. As would be expected, the total trimethyl pentane content of the alkylate is displaced by trimethyl hexanes, but it is interesting to see that the relative distribution among the trimethyl pentanes conforms to the same pattern as for butenes alkylation. . . . It is pertinent to note at this point that 3-methyl l-butene (isoamylene) boils at 66° F., whereas the straight-chain compound l-pentene (amylene) boils at 86° F. Therefore, the light fractions should produce a superior feed. These data were a spearhead for extensive alkylation of light pentenes in practically all the sulfuric-acid alkylation plants in the country.

The last column on this chart shows that pentenes should not be used as marginal olefin feed to HF alkylation plants; but reference to Table 4 gives the data which first indicated that, on a marginal olefin-feed basis, the HF plants do their best job handling propylene wherever this olefin could not be used to good advantage in the production of cumene. It should be noted from this chart that a sulfuric-acid plant charging propylene as marginal olefin feed would have to be cut back in capacity to give almost 70 per cent isobutane in the reactor effluent in order to produce an alkylate in equal quantity to that produced in an HF plant operating at a more normal 45 per cent isobutane in reactor effluent. . . .

Use of Butadiene Byproducts

The petroleum-source butadiene plants built as part of the wartime synthetic-rubber program were producing, as byproduct material, mixtures of diisobutylene and triisobutylene in significant quantities. These highly branched-chain olefins from the sulfuric-acid polymerization units, operated as part of the butadiene purification plants, were given prompt attention as possible sources of aviation blending agents. The first thought was to hydrogenate these materials, but the substantial quantity of trimer present in the material ended up as C_{12} paraffin hydrocarbon, boiling too high to be utilized in aviation fuel. These olefinic materials were then charged to sulfuric-acid alkylation plants as marginal olefin feeds. The results were extremely interesting and gratifying. The process apparently did not recognize that polymers were being charged, the outlet streams showing no apparent change over charging all the olefins as monomer. Table 5 shows the first analyses of samples of alkylate produced from these test operations on dimer and trimer feed stocks bracketed between runs on conventional butene feeds. It can be seen that apparently depolymerization of the feed was effected and the actual alkylation took place in a normal manner. . . .

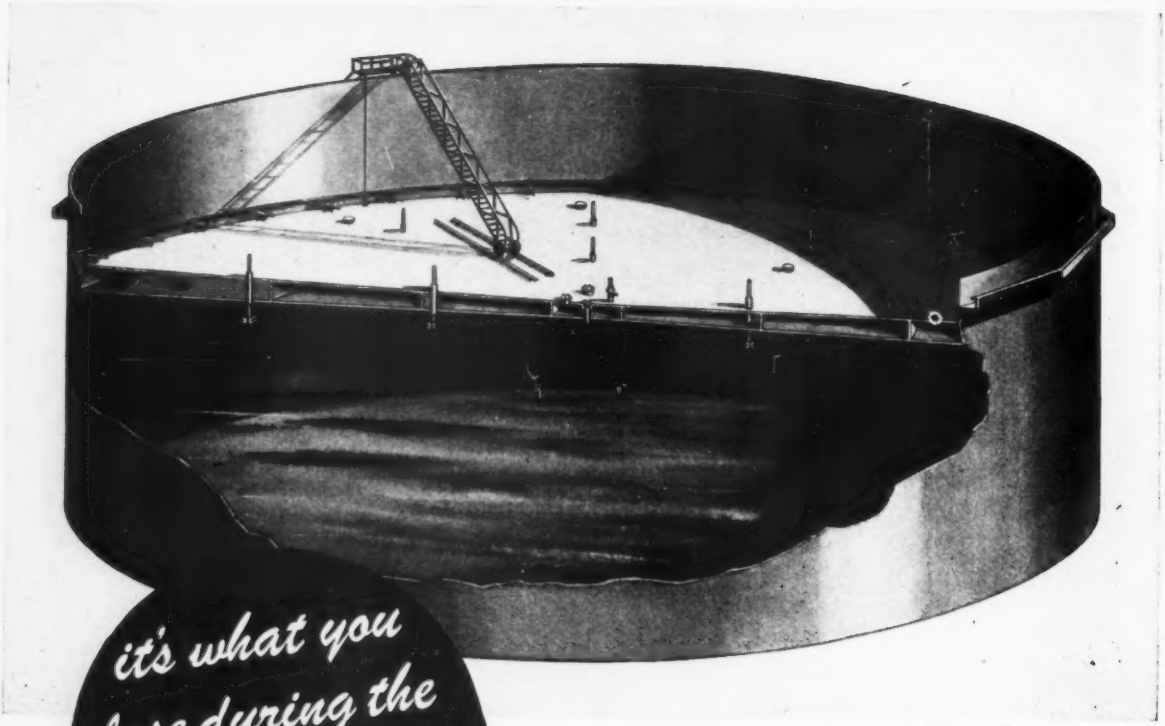
TABLE 6—HYDROPOLYMER—TUBULAR Vs. CHAMBER REACTORS

Sample No.	36	44
Feed comp. ratio: i-Butene / n-Butene	0.54	2.36
2,2,4-TMP, per cent	6.6	27.4
2,2,3-TMP, per cent	10.6	7.9
2,3,4-TMP, per cent	43.9	28.3
2,3,3-TMP, per cent	6.1	3.1
Total TMP's	67.2	66.7
Octane No.:		
F-3 (4 ml. TEL)	104.0	106
F-4 (perf. index)	155	133
Reactor temp., °F.:		
In	340	308
Out	345	324
Olefin conversion, per cent	78.7	92.8
Reaction ratio	2.34	1.41

Study of Hydropolymer Operations

Table 6 depicts the results from a tubular-type plant and a chamber-type of plant. These, and subsequently discussed codimer results, are from laboratory hydrogenation of the plant products, but all efforts were exerted to have laboratory hydrogenations carried out under comparable conditions. In this comparison it is seen that the chamber-type plant produced material of lower octane value, particularly F-4 value, than the tubular-type plant. . . .

As previously mentioned, the samples analyzed by Project 6 gave the first picture of the difference in chemical composition between alkylate and hydropolymer. As the program developed, more samples were analyzed, and the results formed the backbone of a correlation of codimer-plant operating variables which proved to be very valuable. Table 7 presents a comparison in which the major variable considered was reactor temperature. The result of higher reactor temperature is seen to be a degradation of the product quality, even though a higher olefin conversion is obtained. This degradation results in a lower total trimethyl pentane content, but in addition a shift in trimethyl pentanes distribution occurs which tends to offset somewhat the loss in total trimethyl pentanes at least in F-4 value, inasmuch as a higher proportion of the 2,3,4-isomer



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results. It is interesting to note that, just as the previously discussed analysis of alkylates indicated a constancy in pattern of trimethyl pentane distribution, these results on hydrocodimer indicated that the pattern for blending agents from this latter type of operation is not constant, but subject to important variations—depending not only on feed stocks, but also on operating conditions.

TABLE 7—HYDROPOLYMER—REACTOR TEMPERATURE

Sample No.:	41	42
2,2,4-TMP, per cent	11.2	5.2
2,2,3-TMP, per cent	14.8	10.0
2,3,4-TMP, per cent	39.2	37.3
2,3,3-TMP, per cent	7.2	4.6
Total TMP's	72.4	57.1
Octane No.:		
F-3 (4 ml. TEL)	104.5	103.6
F-4 (perf. index)	162	148
Reactor temp., °F. (avg.)	286	337
Olefin conversion, per cent	60.5	86.2
Reaction ratio	2.41	3.61

TABLE 8—HYDROPOLYMER—FEED COMPOSITION

Sample No.:	36 (tube)	37 (chamber)
2,2,4-TMP, per cent	6.6	7.2
2,2,3-TMP, per cent	10.6	8.5
2,3,4-TMP, per cent	43.9	34.9
2,3,3-TMP, per cent	6.1	5.2
Total TMP's	67.2	55.8
Octane No.:		
F-3 (4 ml. TEL)	104.0	103.4
F-4 (perf. index)	155.0	104.0
Reactor temp., °F.:		
In	340	257
Out	345	306
Olefin conversion, per cent	78.7	71.8
Reaction ratio	2.34	1.68

In regard to codimer-plant feed variation, Table 8 is noteworthy. Here the product from plants charging feed stocks of widely variant composition are compared. The first plant (Sample 36) was a domestic plant operating in conventional manner on conventional feed stock. The second plant (Sample 44) was a foreign plant operating on very unusual feed stock having an extremely high ratio of isobutene in the feed. The samples were analyzed to determine the effect of feed composition on product composition. Apparently, due primarily to the feed characteristics and, secondarily, to different catalyst activity, the high isobutene feed operation resulted in a very high olefin conversion at a lower reactor temperature than was the case for the conventional operation. Under these conditions the high-isobutene feed produced a hydrogenated product with substantially higher F-3 octane value, but with a considerably lower F-4 value than was normal experience. Examination of the trimethyl pentane distribution in these samples furnishes an interesting comparison. The finished blending agent in the unusual case contained a normal amount of total trimethyl pentanes, and the distribution of these trimethyl pentanes was anything but normal for codimer operations. The high concentration of isobutene in the feed to the reactors forced the reaction toward production of an abnormally high proportion of 2,2,4-trimethyl pentane; the other trimethyl pentanes held a normal distribution. This abnormality caused the quality effect noted. . . .

References

1. TAC reports: AMC-1, AMC-2, and AMC-3.
2. Augustus R. Glasgow, Jr., Anton J. Streiff, Charles B. Willingham, and Frederick D. Rossini, "Report on Analyses of Alkylates and Hydrocodimers," Proc. A.P.I. 26 (III) —— (in process) (1946).

Alexander Clark, senior geologist of the Ventura coastal division of Shell Oil Co., Inc., has been transferred to Casper, Wyo. Other transfers of Shell's California personnel include: **Roy Hershberger,** senior surveyor, Los Angeles office to the Los Angeles basin division; **Roy Robinson,** drilling foreman, Ventura coastal division to the San Joaquin division at Sacramento; and **Florentin P. Webb,** surveyor, Long Beach to the Los Angeles office.

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Correlation of Operating Variables In the Polyform Process

by Joel H. Hirsch, P. Ostergaard†, and W. C. Offutt**

A.P.I.

WHEN operating the Polyform process on naphtha, the yields, throughputs, and product properties are related to: character of fresh charge, and by amount and composition of fresh gas; severity of treatment; extent of recovery and recycling of C_3 and C_4 fractions; and operating pressure of lesser effect than the first three variables. Under the same conditions, the effect of propane ratio on the properties of the product is to raise the octane motor method rating and C.F.R. research rating by 4.0 and 8.0 numbers, respectively, when the propane ratio is 0.65. Gasoline yields may be boosted by about 35 per cent of the propane converted. The "index of severity" of treatment is based on the production of "C_2's and lighter" formed during the operation.

TO provide the most efficient utilization of the Polyform process in present-day refinery operations, a generalized correlation has been prepared, based on data from a large number of pilot-plant runs. Using this correlation, it is possible to calculate the yields of hydrogen, methane, ethane, ethene, propane, propene, butanes, butenes, isopentane, n-pentane, pentenes, C_6 to 400° F. end-point fraction, and tar; C.F.R. motor and research octane numbers, with and without the addition of tetraethyl lead; the rate at which propane, propene, butanes, and butenes must be recycled for a given conversion; and the amount of reaction coil volume required to obtain the desired conversion with a given heater temperature gradient.

Although the correlation is general, the examples in the present paper deal with the polyforming of 200° to 400° F. eastern Venezuela naphtha (Table 1) at a pressure of 1,500 psi.,

TABLE 1—PROPERTIES OF EASTERN VENEZUELA NAPHTHA CHARGE

Gravity, °A.P.I.	46.8
A.S.T.M. distillation, (°F.):	
Initial boiling point	220
10 per cent point	304
30 per cent point	318
50 per cent point	329
70 per cent point	342
90 per cent point	374
End point	420
Aniline point (°F.)	117
C.F.R. motor octane number	45.6
C.F.R. research octane number	47.9
Characterization factor[3]	11.67

both with and without the addition of outside C_3 fractions, and illustrate the calculation procedure employed. The complete correlation covers 139 pilot-plant runs on 17 charge stocks—ranging from Rodessa naphtha to 12.2 characterization factor[3] and 22 C.F.R. motor octane number, to catalytic cracked naphtha of 11.1 characterization factor and 77.4 C.F.R. motor octane number. It is applicable both to straight or self-contained polyforming, and to polyforming with the addition of outside C_3 and C_4 fractions, ranging up to 60 per cent by volume of the naphtha charge, and varying in olefin content from 0 to 60 per cent by volume.

In making this correlation the pilot-plant data were first converted to a once-through basis from a series of material balances around the stabilizer and absorber. The amount of each component, from hydrogen through tar, entering and leaving the polyform coil was determined for each run. In this way the straight polyform runs and runs with outside gas were placed on a comparable basis, the principal difference being in the relative amounts of some components such as propane and propene present at the coil inlet. This difference made the calculation of the effects of individual components on yields and octane numbers possible.

Experience in previous correlations has shown the convenience of using an appropriate severity index which can be related to product yields and product characteristics on the one hand, and to operating variables such as time and temperature on the other. Having placed all of the polyform runs on a common basis, the next step was, therefore, to find a suitable severity index. Selection of a severity index for the Polyform process was limited by the fact that so many of the light gaseous components are recycled. It was necessary to find an index in which no substantial amount of the components would be recycled or, if recycled, would not be further converted to any appreciable extent. This narrowed the choice to "C_2's and lighter formed" expressed as per cent by weight of the total stream fed to the reaction coil. Reaction velocity studies later showed that this was a fortunate choice.

It has been found that yields, throughputs, and product characteristics can all be related as functions of four major variables:

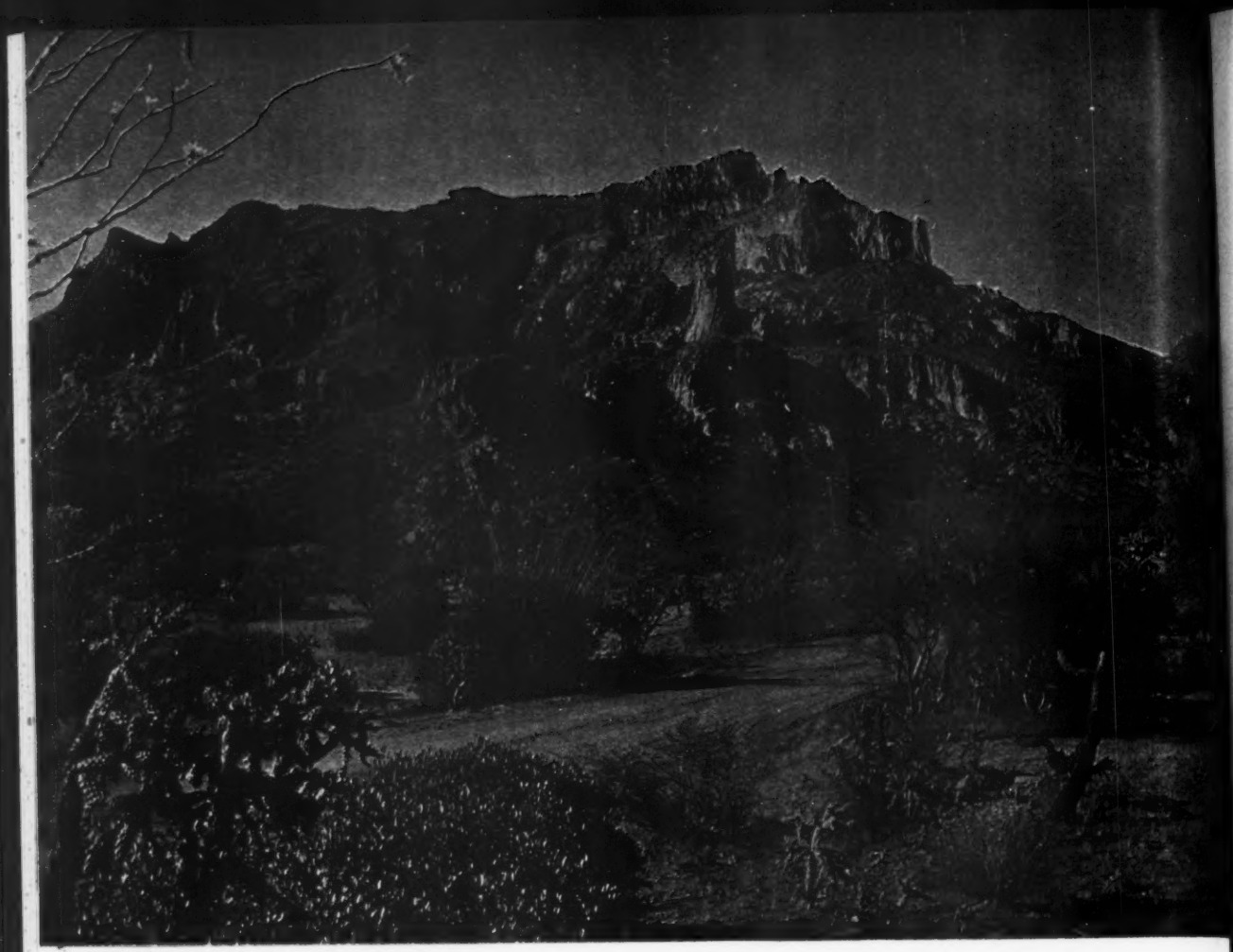
1. Character of fresh charge, as defined by naphtha octane number and characterization factor, and by amount and composition of outside gas.
2. Severity of treatment, as indicated by the "C_2's and lighter" severity index.
3. Extent of recovery and recycling of C_3 and C_4 fractions, as determined by operation of the absorber and stabilizer.
4. Operating pressure, which is a variable of lesser effect than the other three.

Yield Correlation

Preparation of the yield correlation was aided by the fact that a number of pilot-plant runs were made charging practically pure propane as outside gas. From the increase in yield for these runs over those from straight polyforming, the incremental effect of propane was determined. In other runs mixtures of propane and propene were charged as outside gas, and the incremental yield due to propene could thereby be evaluated. Similarly, incremental yields for butanes and butenes were determined. It is these incremental yields that are shown in Figs. 2 and 3.

Yields for butanes and butenes are based on relatively few runs, so that these relations cannot be used with as great assurance as those for propane and propene. They are included as tentative relations, pending more complete pilot-plant data which are now being obtained. The following average yields from butanes are be-

*Gulf Research & Development Co., Pittsburgh. †Gulf Oil Corp., Pittsburgh.



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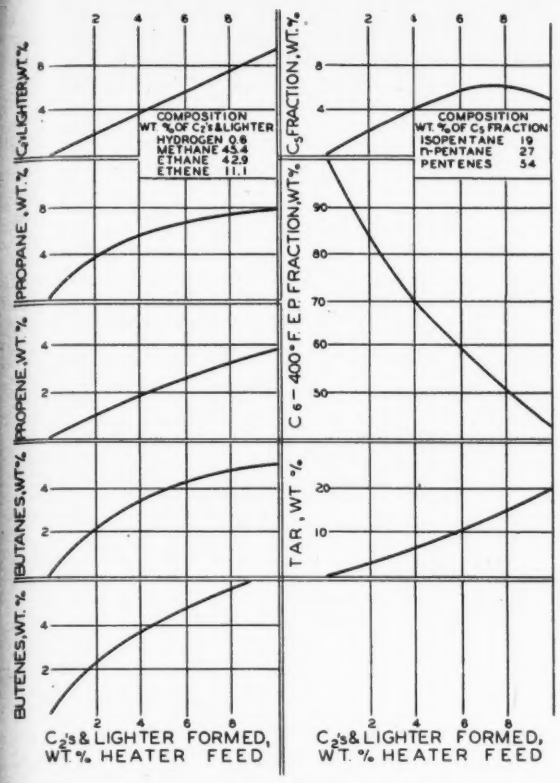
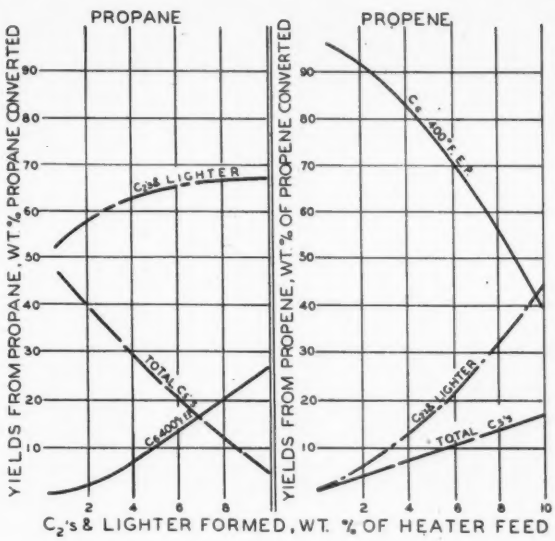


Fig. 1—Yields from Eastern Venezuela naphtha charge at 1,500 psi.


PROPANE
PROPENE
YIELDS FROM PROPANE, WT % PROPANE CONVERTED
YIELDS FROM PROPENE, WT % OF PROPENE CONVERTED
C2's & LIGHTER
TOTAL C4's
C6 400° F. EP
C2's & LIGHTER
TOTAL C3's
C2's & LIGHTER FORMED, WT. % OF HEATER FEED

COMPOSITION OF C_5 AND LIGHTER FRACTION, PER CENT BY WEIGHT OF FRACTION

Hydrogen	0.6
Methane	45.4
Ethane	42.9
Ethene	11.1

COMPOSITION OF C_5 FRACTION, PER CENT BY WEIGHT OF FRACTION

Isopentane	19
n-Pentane	27
Pentenes	54

Fig. 2—Yields from propane and propene at 1,500 psi.

ing used at present for all values of severity index:

	Per cent by wt. of butanes converted
C_2's and lighter	32.5
C_5 fraction	16.6
C_6 to 400° F. end-point fraction	50.9

In making the yield studies on butanes, it was found that the butanes go through intermediate products in the process of being converted to the final products tabulated above. The amounts of these intermediate products, propane and propene, are shown in Fig. 4. These must be taken into account in calculating heater circulation rates, but not in calculating ultimate yields.

It was found that the composition of the C_2's and lighter and C_5 fraction, for all operations studied, could be presented satisfactorily by the averaged values shown below Fig. 2.

The relationships employed in calculating yields from the Polyform process are given in Figs. 1 to 3, inclusive. A sample calculation is shown in Table 2. Fig. 1 gives the yields of various components from eastern Venezuela naphtha at a pressure of 1,500 psi. as a function of per cent by weight C_2's and lighter. At any given severity the yields from the naphtha alone are set down in a calculation sheet similar to Table 2. The amounts of various components charged are also set down. Components such as propane, propene, butanes, and butenes charged to the process are added to the amounts of those components made from the naphtha to give the total present. From this total are subtracted the amounts of these components leaving the process in the gas and polyform distillate, giving the amount converted. From the amount of each component converted and the yields in Fig. 2 and 3, the yields of various products from C_2 and C_5 fractions are determined and added to those from the naphtha. Thus, it is seen that the calculation of a polyform yield by this procedure is as simple as making a material balance. Complete yields for a wide variety of polyform conditions can be readily calculated.

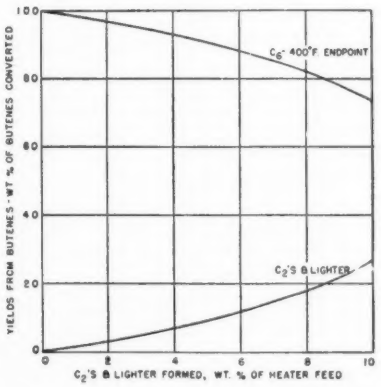


Fig. 3—Yields from butenes at 1,500 psi.

Yields on a per-cent-by-weight basis have been used in preference to the more conventional per-cent-by-volume basis because of the much greater convenience in making calculations.

The accuracy of the yield calculation procedure is shown by the following tabulation of average deviations for 110 pilot-plant runs:

	Avg. deviation as % by wt. of naphtha charge
Hydrogen	±0.016
Methane	±0.69
Ethane	±0.76
Ethene	±0.38
C_2's and lighter	±1.03
Isopentane	±0.38
Pentane	±0.41
Pentenes	±0.85
Total C_5 fraction	±1.13
C_6 to 400° F. end-point fraction	±2.46
Tar	±1.72

No deviations are shown for propane, propene, butanes, and butenes, because net yields of these compounds cannot be predicted from the correlation alone. These are recycled in the Polyform process, and in most operations represent both charge and products. Yields of these compounds depend not only on the reaction coil, but to an even greater extent on the design and operation of the gas-recovery equipment. Thus, the net yields of propane, propene, butanes, and butenes can be varied between

TABLE 2—SAMPLE CALCULATION—NAPHTHA POLYFORMING

Yield Calculation Sheet

(Per cent by weight of naphtha charge, except where noted)

Description and conditions of operation	Component	Amount charged	Amount made from naphtha	Total	Net yield	Amount converted	C_2's and lighter: Composition (†) fraction (per cent by weight): Hydrogen	Methane	Ethane	Ethene	C_2's and lighter: Total: Wt. per cent of component	Wt. per cent of naphtha charge	C_3 fraction: Propane	Propene	Butanes	Butenes	Composition (†) (per cent by weight): Isopentane	Pentane	Pentenes	C_3 fraction: Total: Wt. per cent of component	Wt. per cent of naphtha charge	C_4 to 400° F.: Wt. per cent of component	Wt. per cent of naphtha charge	Tar	Conversion per pass	Circulations: Circulation per cent by wt. of naphtha	Density of naphtha component	Circulation per cent of volume of naphtha
Run No. 1	Naphtha	100.0					0.6	45.4	42.9	11.1							19.0	27.0	54.0									
Stock eastern Venezuela	Propane	...	6.4	6.4	†0.6	5.8	...	...	...	...	65.6	3.8	...	...	...	...	...	...	...	20.7	1.2	13.7	0.8	...	11.4	44.5	1.556	69.3
K 11.67	Propene	...	2.6	2.6	†0.3	2.3	...	...	...	...	20.7	0.5	...	...	...	...	...	...	...	9.8	0.2	69.5	1.6	...	27.0	5.9	1.509	8.9
Pressure 1,500 psi.	Butanes	...	4.2	4.2	‡3.8	0.4	...	...	...	...	32.5	0.1	...	...	...	...	...	...	...	16.6	0.1	50.9	0.2	...	...	...	...	...
6.0*	Butenes	...	4.7	4.7	‡4.2	0.5	...	...	...	...	11.8	0.1	...	...	...	...	...	...	...	0	0.0	88.2	0.4	...	...	...	...	...
Straight polyforming	Miscellaneous charge	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Total	100.0	...	—	—	—	0.1	4.6	4.4	1.1	—	10.2	0.6	0.3	3.8	4.2	1.4	1.9	3.9	—	7.2	—	62.7	11.0	—	—	—	—
Run No. 2	Naphtha	100.0																										
Stock eastern Venezuela	Propane	14.9	6.4	21.3	‡2.1	19.2	...	...	...	...	65.6	12.6	...	...	...	...	...	...	...	20.7	4.0	13.7	2.6	...	11.4	162.1	1.556	252.5
K 11.67	Propene	22.2	2.6	24.8	‡2.5	22.3	...	...	...	...	20.7	4.6	...	...	...	...	...	...	...	9.8	2.2	69.5	15.5	...	53.0	39.5	1.509	59.6
Pressure 1,500 psi.	Butanes	0.3	4.2	4.5	§4.0	0.5	...	...	...	...	32.5	0.2	...	...	...	...	...	...	...	16.6	0.1	50.9	0.2	...	...	...	...	...
6.0*	Butenes	0.4	4.7	5.1	§4.6	0.5	...	...	...	...	11.8	0.1	...	...	...	...	...	...	...	0	...	88.2	0.4	...	...	...	...	...
Polyforming with addition of outside C_3 fraction	Miscellaneous charge	0.9	...	...	...	...	...	...	0.9	...	...	0.9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	Total	138.7	...	—	—	—	0.1	10.5	10.9	2.6	—	21.1	2.1	2.5	4.0	4.6	2.3	3.2	6.5	—	12.0	—	78.4	11.0	—	—	—	—

*Severity index, C_2's and lighter formed, per cent by weight of heater feed. †These compositions are the average distributions observed in the pilot-plant data. ‡Based on 90 per cent C_3 recovery. §Based on 10 per cent C_4 recovery.

zero and the total amount of each of these components charged and made from the naphtha, by changing the degree of recovery in the stabilizer and absorber.

Required Circulation of Components

Figs. 5 to 8, inclusive, present relationships between the conversion per pass (γ) of propane, propene, butanes, and butenes and the severity index. From these relations, the required amount of each component (c) in the heater feed, per unit of naphtha charge, can be calculated with the aid of the following equation:

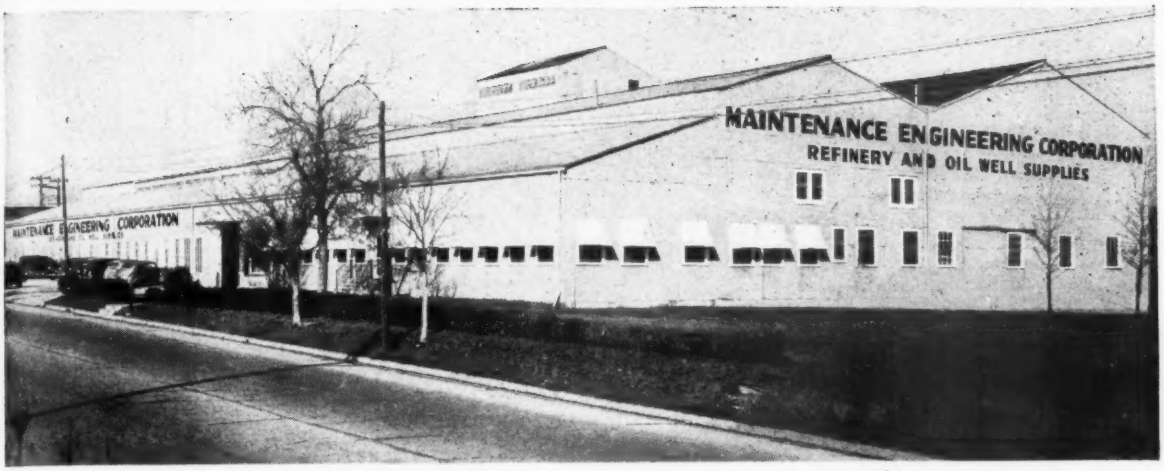
$$\gamma = \frac{P + b + g - e}{P + b + c}$$

where

- γ = conversion of any given component per pass (weight fraction of the component charged and made).
- P = amount of the component made from the naphtha read from Fig. 1.
- b = amount of the component made from butane calculated from Fig. 4. (Applies only to calculation of C_3's circulated.)
- g = amount of the component charged as outside gas, expressed as per cent by weight of naphtha charge.
- e = net yield of the component eliminated from the unit, expressed as per cent by weight of naphtha charge. This is dependent on operation of the gas-recovery equipment.
- c = rate of circulation, i.e., heater feed rate, of the particular com-

Fig. 4—Intermediate yields of propane and propene from butanes

Fig. 5—Propane converted per pass



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ponent expressed as per cent by weight of naphtha charge.

Sample calculations are given in Table 2.

Fig. 5 presents the conversion-per-pass factor (γ) for propane as a function of the severity index. Using the foregoing equation, together with Fig. 5, it is possible to calculate the required propane circulation within an average deviation of ± 11.8 per cent by weight (basis naphtha charge).

Fig. 6 presents the conversion-per-pass factor (γ) for propene in nomograph form as a function of severity index, operating pressure, and the olefin concentration of the outside C_3 fraction charged plus that made from naphtha. This relationship permits calculation of required propene circulation within an average deviation of ± 4.6 per cent by weight (basis, naphtha charge).

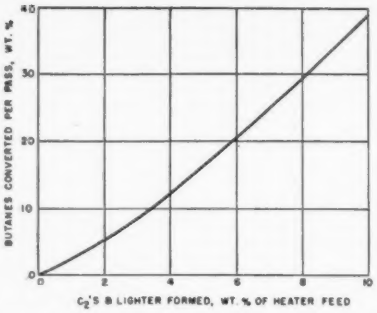


Fig. 7—Butanes converted per pass at 1,500 psi.

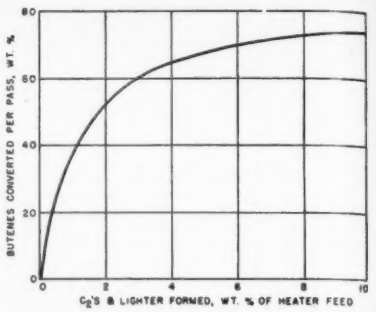


Fig. 8—Butenes converted per pass at 1,500 psi.

Fig. 7 gives the conversion-per-pass factor (γ) for butanes, and Fig. 8 gives this factor for butenes as a function of C_3's and lighter. Like the corresponding yield values, these relations are only tentative, pending more complete data.

Octane-Number Correlation

Figs. 9 and 10 give the C.F.R. motor and research octane numbers of polyform gasoline produced from eastern Venezuela naphtha as functions of the "C_2's and lighter" severity index, and the weight ratio (a) of propane in the heater feed to the total propane plus naphtha in the heater feed.

The effect of propane circulation in raising octane numbers is one of the interesting features of the Polyform process. Taking a propane ratio of zero to correspond to thermal reforming, it will be seen that at a propane ratio of 0.65, corresponding to

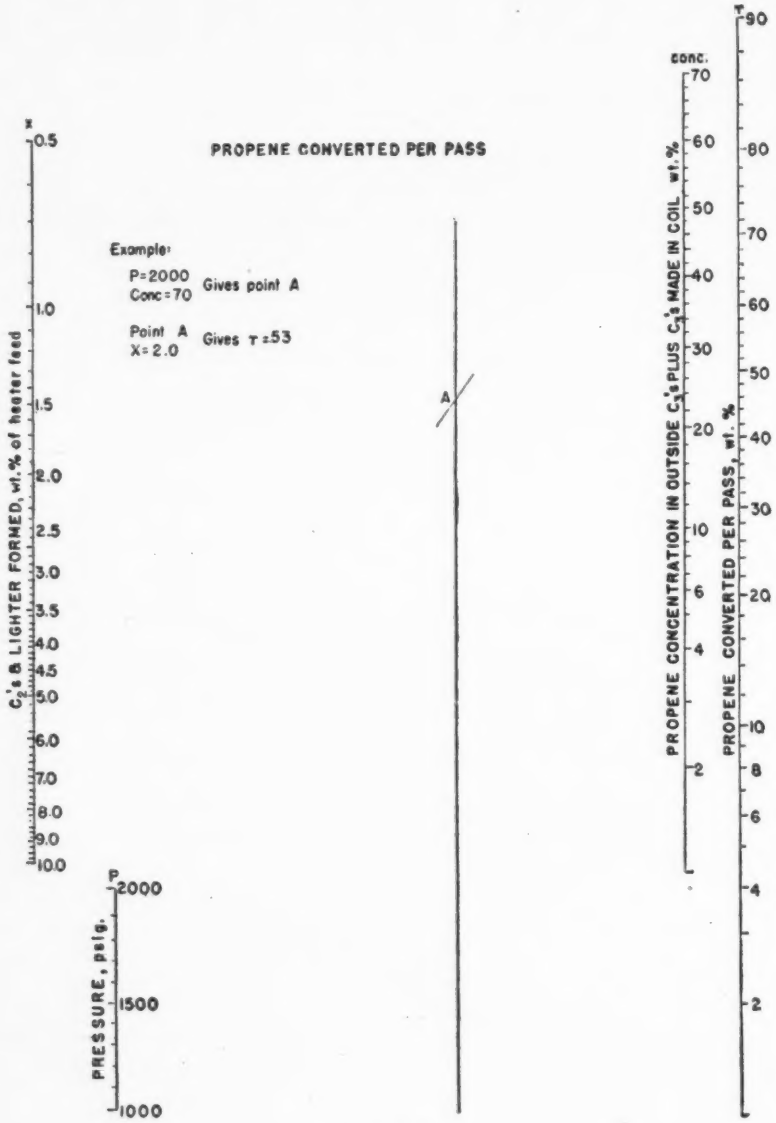


FIG. 6

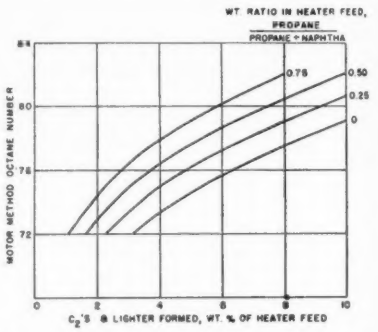


Fig. 9—C.F.R. motor octane number of 10-R.v.p. gasoline

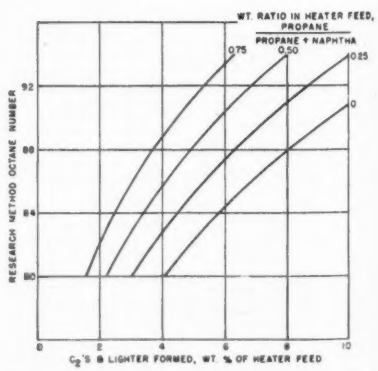
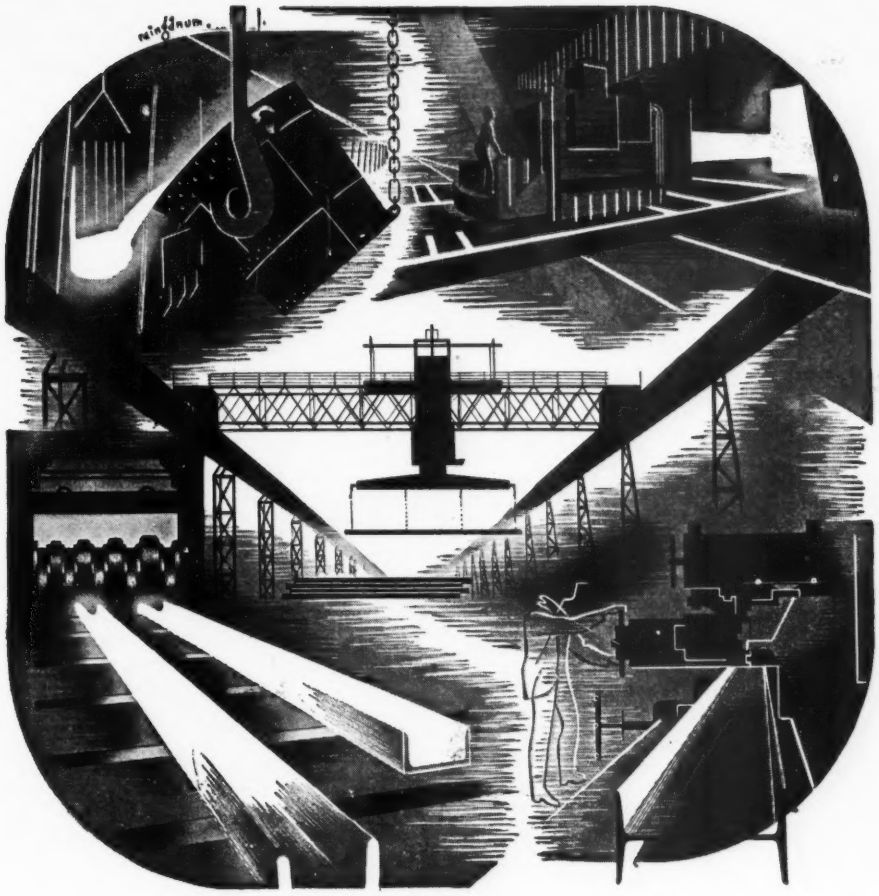


Fig. 10—C.F.R. research octane number of 10-R.v.p. gasoline



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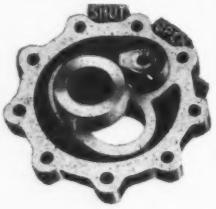

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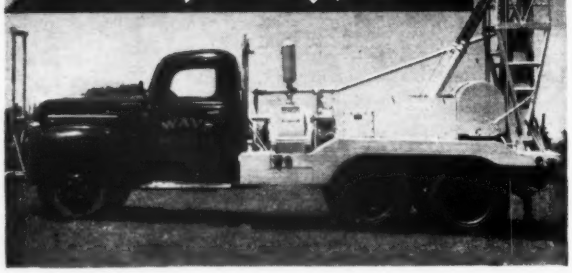

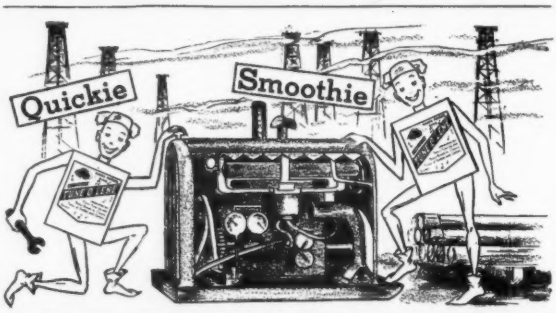

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polyforming with 16 per cent by weight outside propane (basis, naphtha charge), the C.F.R. motor and C.F.R. research octane numbers are approximately 4.0 and 8.0 higher, respectively, at the same severity. Actually, the over-all advantage is greater than this, because the presence of circulated propane permits operating at greater severity without coking; and increased gasoline yields are obtained, amounting to some 35 per cent by weight of the propane converted.

By taking account of the charge octane number and characterization factor, it has been possible to generalize the relationships of Figs. 9 and 10 to cover a wide range of naphtha charge stocks. The average deviation of observed values from those predicted by these generalized expressions is ±1.09 C.F.R. motor octane numbers and ±1.48 C.F.R. research octane numbers.

Using Eastman's method[1] together with these octane expressions it is possible to calculate the leaded octane numbers of polyform gasoline containing up to 3 ml. of tetraethyl lead per gallon, within an average deviation of ±1.07 C.F.R. motor and ±1.34 C.F.R. research octane numbers. Eastman's method correlates a lead response factor (ϕ) with per cent by weight of sulfur by the lamp method, and the unleaded octane-number sensitivity (C.F.R. research minus C.F.R. motor) of the gasoline.

Correlation of "C_3's and Lighter" Severity Index With Operating Conditions

Having found that "C_3's and lighter" formed per pass was an index of severity of treatment which could be correlated with yields, octane numbers, and required heater circulation rates, the final step comprised tying this index to operating conditions. This was done through a procedure for calculating conversion per pass and pressure drop in tubular reaction coils, which has been previously described.[2]

As brought out by Hirsch, Crawford, and Holloway,[2] this method involves determining reaction velocity constants from laboratory pilot-plant runs, and then using these constants to calculate the amount of conversion that will take place in a proposed commercial reaction coil. A plot was presented which correlates reaction velocity constants from polyforming runs with the weight ratio (a) of propane in the heater feed to the sum of propane plus naphtha, and the aniline point of the naphtha charge. The average deviation of the reaction velocity constants from this plot is ±11 per cent.

When "C_3's and lighter formed" is used as a measure of the severity of thermal treatment, the reaction velocity constant is relatively independent of charging stock. For example, the value for propane at 800° F. is 3×10^{-6}, whereas that for 23° A.P.I. topped East Texas crude at the same temperature is only 9×10^{-6}. This difference is much smaller than when reaction velocity is expressed in terms of material decomposed. On this basis C_3's and lighter would be the main products in cracking propane, and the constant would still be about 3×10^{-6}. However, gas and gasoline would be the major decomposition products from topped East Texas crude and "per cent by weight of gas plus gasoline formed" would be the conventional index for expressing cracking. Here the reaction velocity constant would be about 240×10^{-6}, or 80 times that of propane. Thus, although high-boiling stocks such as topped crudes crack to gas and gasoline at relatively high rates, they still form C_3's and lighter at roughly the same rate as lower boiling stocks. Reaction velocity constants based on "C_3's and lighter" are independent of operating pressure.

Preliminary studies indicate that the procedures illustrated in this paper can also be applied to gas-oil polyforming operations. Thus it would appear that the correlation methods employed are sufficiently fundamental to cover a fairly wide range of

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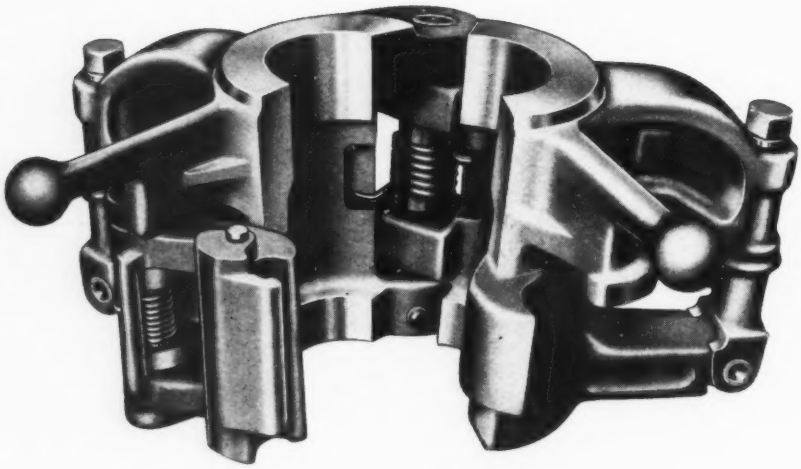

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problems, and that "C_4's and lighter" may be a promising new instrument for correlating yields, product characteristics, and operating conditions in thermal conversion operations.

References

1. Eastman, Ind. Eng. Chem. 33, 1555 (1941).
2. Hirsch, Crawford and Holloway, Ind. Eng. Chem. 38, 885 (1946).
3. Smith and Watson, Ind. Eng. Chem. 29, 1408 (1937).

Corrosion and Preventive Methods in the Katy Field

By R. C. Buchan*

A.P.I. Abstract—Author's "Conclusions"

CORROSION encountered at Katy is typical of that found in many condensate fields. Experience in that field will aid in minimizing corrosion losses in other fields.

Two methods of preventing corrosion, viz., (1) use of plastic-coated steel and, (2) use of neutralizing agent, appear to be useful for reducing the corrosion expense at Katy. The chemicals tried as inhibitors have not been satisfactory. Other chemicals are being tried in individual wells.

Research work has aided materially as a background for full-scale field experiments. Considerably more research is required to obtain a better understanding of phenomena observed in the field. Continued research is needed to cope with continuously changing conditions in condensate fields and to correlate more closely field tests with laboratory tests.

Continued support should be given to the N.A.C.E. high-pressure well-corrosion committee in an effort to hasten the systematic testing of alloys in condensate-well service.

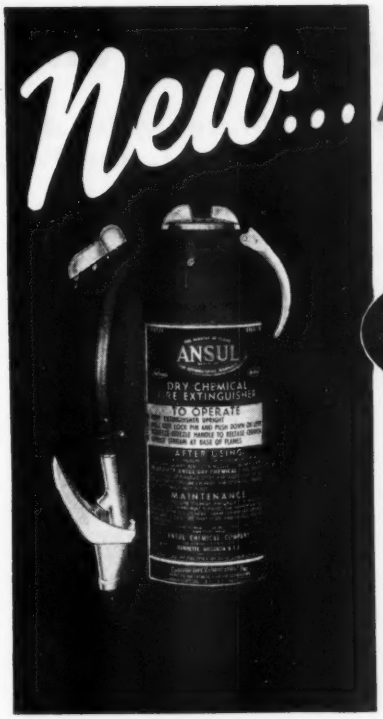
Operators should expect corrosion in condensate fields, and should take corrosion into account when developing new fields or when reworking old fields.

Inspections made early in the life of a field would result in equipping wells so that corrosion control is facilitated, and will reduce corrosion losses. The newer tools—such as caliper surveys and radium inspections—allow rapid, accurate determinations to supplement visual inspections and water analyses.

In fields where corrosion is found, early field trials of promising methods should be made rather than waiting until all of the questions are answered by laboratory studies.

Keeping equipment in a safe operating condition is considered more important than the monetary losses due to corrosion in condensate fields.

*Humble Oil & Refining Co., Houston.



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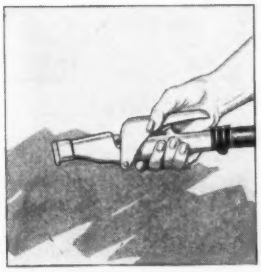

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Analysis of Alkylates and Hydrocodimers

by A. R. Glasgow, Jr., A. J. Streiff† C. B. Willingham, and F. D. Rossini‡*

A.P.I.

(This is an abstract of work by the American Petroleum Institute Research Project 6 on the analyses, with respect to individual hydrocarbon components, of 28 different alkylates and hydrocodimers.)

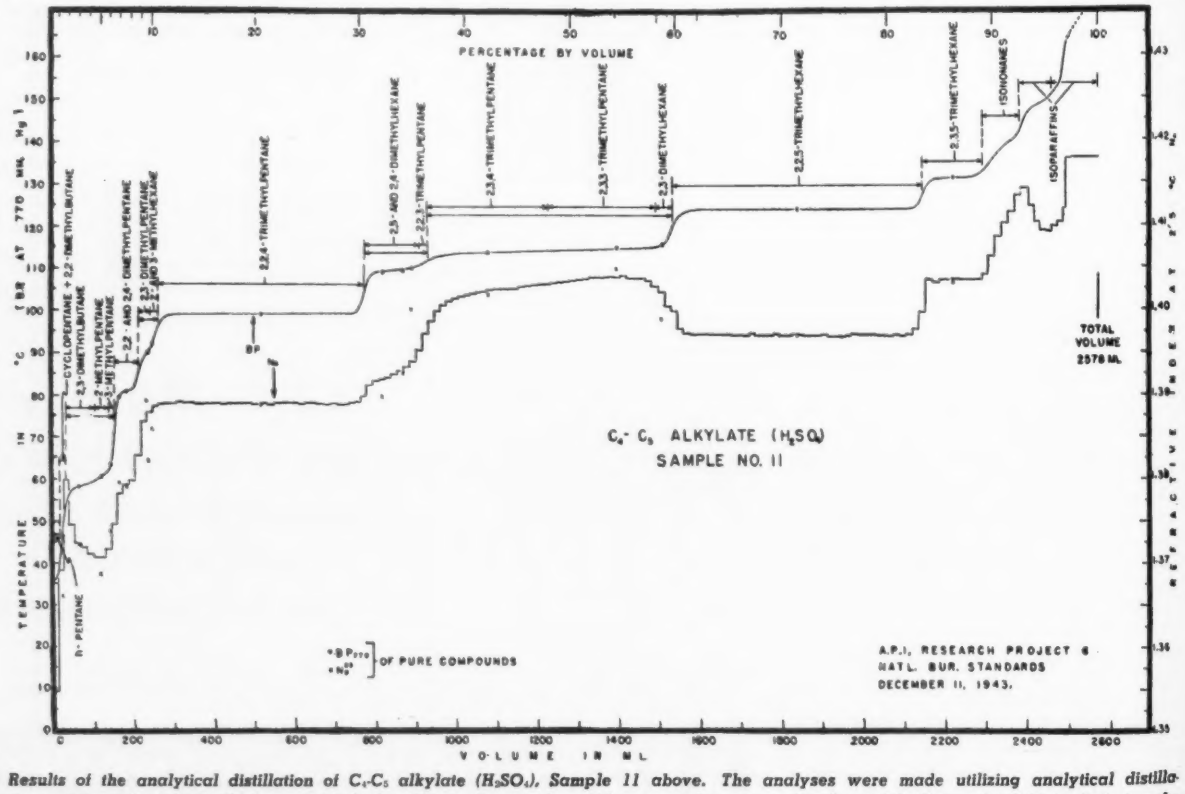
ANALYSES are reported on the hydrocarbon composition of 15 sulfuric acid alkylates, 5 HF alkylates, and 8 hydrocodimers from various sources. These analyses were carried out with high efficiency, high reflux-ratio distillation units, determining accurately the boiling points and refractive indices of the fractions. Six laboratories collaborated in spectrographic analyses of one of the C_4 alkylates, using 1 Raman, 1 mass, and 4 infrared spectrometers.

The accompanying table shows the percentages of hexanes, heptanes, octanes, nonanes and higher paraffins found in the 28 samples of alkylate and hydrocodimers.

*National Bureau of Standards, Washington, D. C. †Research associate, A.P.I. Research Project No. 6. ‡Supervisor, A.P.I. Research Project No. 6, National Bureau of Standards.

RELATIVE AMOUNTS OF HEXANES, HEPTANES, OCTANES, AND NONANES AND HIGHER PARAFFINS, IN 20 ALKYLATES AND 8 HYDROCODIMERS

Sample No.	Material	Relative amount by volume: Hexanes	Heptanes	Octanes	Nonanes plus higher paraffins	Total
20	C_3 Alkylate (H_2SO_4)	5.3	65.7	18.0	11.0	100.0
17	C_3 Alkylate (HF)	5.0	41.5	29.7	23.8	100.0
16	C_3-C_4 Alkylate (HF)	2.3	10.2	60.3	27.2	100.0
1	C_4 Alkylate (H_2SO_4)	8.8	6.7	67.5	17.0	100.0
2	C_4 Alkylate (H_2SO_4)	12.6	1.3	63.7	12.4	100.0
9	C_4 Alkylate (H_2SO_4)	8.3	7.5	68.2	16.0	100.0
10	C_4 Alkylate (H_2SO_4)	9.4	7.7	73.1	9.8	100.0
24	C_4 Alkylate (H_2SO_4)	2.1	2.1	92.5	3.3	100.0
27	C_4 Alkylate (H_2SO_4)	6.8	7.0	67.0	19.2	100.0
13	C_4 Alkylate (HF)	2.1	4.5	83.6	9.8	100.0
15	C_4-C_5 Alkylate (HF)	1.5	3.5	65.2	29.8	100.0
11	C_4-C_5 Alkylate (H_2SO_4)	5.0	4.2	49.9	40.9	100.0
7	C_5 Alkylate (H_2SO_4)	5.8	3.5	30.6	60.1	100.0
12	C_5 Alkylate (H_2SO_4)	6.0	3.8	28.7	61.5	100.0
22	C_5 Alkylate (H_2SO_4)	3.2	2.4	45.9	48.5	100.0
23	C_5 Alkylate (H_2SO_4)	4.4	3.2	36.5	55.9	100.0
14	C_5 Alkylate (HF)	1.6	3.3	39.6	55.5	100.0
34	Dimer (hot-acid) alkylate (H_2SO_4)	4.9	4.3	80.0	10.8	100.0
21	Trimer (hot-acid) alkylate (H_2SO_4)	5.9	7.8	66.0	20.3	100.0
43	Trimer (cold-acid) alkylate (H_2SO_4)	8.4	8.6	70.8	12.2	100.0
35	Hydrocodimer (hot-acid)	0.2	1.0	95.8	3.0	100.0
4	Hydrocodimer (solid phosphoric-acid)	0.7	2.8	90.7	5.8	100.0
33	Hydrocodimer (phosphoric-acid)	1.5	0.9	92.3	5.3	100.0
36	Hydrocodimer (Lawrenceville)	0.8	2.7	83.9	12.6	100.0
37	Hydrocodimer (Tulsa)	2.6	19.9	70.6	6.9	100.0
41	Hydrocodimer (Lima 6)	0.5	2.0	85.5	12.0	100.0
42	Hydrocodimer (Lima 7)	0.5	3.2	78.1	19.2	100.0
44	Hydrocodimer (HSO-1684)	0.8	10.1	74.6	14.5	100.0



Results of the analytical distillation of C_4-C_5 alkylate (H_2SO_4), Sample 11 above. The analyses were made utilizing analytical distillations performed at high efficiency with high reflux ratio, together with accurately measured values of boiling point (obtained during the distillation) and of refractive index of the fractions of distillate

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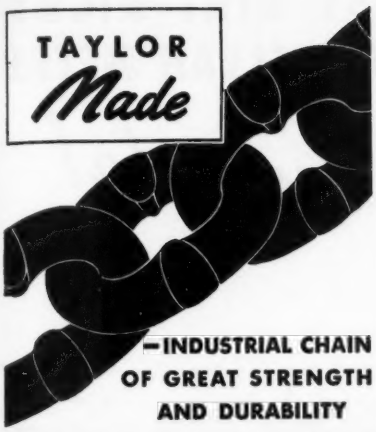

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Relationship of Free Enterprise To Modern Traffic Facilities

by L. S. Wescoat

NO doubt you are familiar with the physical aspects of limited-access highways. Besides owning and controlling the road itself, the state also owns and also controls the roadside for a considerable depth along a limited-access highway.

What this means is that no commercial establishment can operate on a limited-access highway except under one of two conditions: Either it is operated as a commercial enterprise by the state itself, or it is licensed under an exclusive contract granted by the state. In either instance, the control of the state is absolute, and it prescribes the terms under which the establishment will operate.

This, assuredly, is not free enterprise.

Threat of Extension

It is unnecessary to outline in detail the obvious objections to state operation of commercial facilities on limited-access highways. I need only ask the questions which I hope people will ask themselves should this possibility appear in any state. These questions are: If the state enters the oil business on one highway, the next step may be to do the same on all highways. And once having engaged in the oil business, progressive steps might well include the grocery business, the restaurant business, the hotel business, and every other business, trade and profession. . . .

Exclusive Contract

Let us consider the other case wherein the state, instead of actually engaging in business itself, grants the commercial rights on a limited-access highway to a private company on an exclusive-contract basis. Generally this is done through a system of competitive bidding, so that the company which agrees to pay the heaviest charges and submits to the stringent terms laid down by the state is the one that obtains the franchise.

When this policy is adopted by a state in connection with its limited-access highways, what chance does small business have? How can the small businessman, the independent marketer, enter into competition to obtain such a franchise? Where does the war veteran, who wants to open a service station of his own, fit into this picture? Would the actual effect of this exclusive-contract policy be altered if the state adopted a law to the effect that all small business would be barred from its heaviest traveled highways—those of limited-access design? Suppose the issue were put to the American people in this form; there is no doubt of where they would stand.

Furthermore, when all the service stations along a route are operated by one source, whether it be the state or a single company, what is the situation? This doesn't look like a free, open, and competitive market. If it isn't monopoly, what is it?

True, it would not be a monopoly contrived by private individuals, for the petroleum industry has vigorously opposed this system. It would be a monopoly created, composed, and compelled by the state. But that makes it no less a monopoly, and gives it no more favor in the eyes of the American people.

How About Free Choice?

Then, also consider the motorists on these highways who, as Americans, admire efficiency—in fact, demand it—and who insist upon choosing their products according to their tastes? With competition suppressed, what would be the spur to efficient service? . . .

Five states have already given consideration to these questions, and have followed the course of statesmanship, viz., the guidance of public opinion. In four of these states—Pennsylvania, New Hampshire, Indiana, and New Jersey—commercial facilities have been barred by law from the state-owned properties pertaining to limited-access highways. In a fifth, New York, Commissioner of Public Works Charles H. Sells has enforced the same principle by announcing that no service stations would be built on the state-owned right-of-way of the Buffalo - New York Thruway.

Private Property

Feeder roads—marked to indicate availability of commercial facilities—will lead motorists on the limited-access highways of these states to servicing and other business facilities which will be operated as free, competitive enterprises because they will be situated on private property, outside the state's right-of-way.

The solution adopted by these states — and, I hope, soon to be adopted by all states with limited-access highway laws—not only conforms with the petroleum industry's policy of free competition (which we believe is important), but also preserves the cherished principles of the American people (which we know is infinitely more important). I might add that U. S. Commissioner of Public Roads Thomas H. MacDonald is familiar with the petroleum industry's position on this question, and has indicated that he is sympathetic and understanding. . . .

How About the Cities?

Every objection that can be raised against commercial establishments along limited-access highways applies equally to commercial establishments within municipal parking, bus, and truck terminals. For the public ownership and nature of the property are such that there can be no free enterprise within these facilities, but only enterprises owned by government or controlled by government under an exclusive contract. . . .

The Trend

In recognition of these facts, five states—Indiana, Michigan, Mississippi,

(Continued on page 253)

A.P.I.

L. S. Wescoat, of Pure Oil Co., Chicago, is chairman of the A.P.I. committee on highways and is widely recognized as an authority on taxation and similar problems confronting the petroleum industry. These remarks are from his address before the group session on taxation at the Chicago meeting. In the forepart of his talk, not included here, Wescoat points out the favorable public acceptance of limited access-highways and emphasizes the traditional American belief in free enterprise.

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Recent Developments in Pipe-Line Technology

*by H. H. Anderson**

A.P.I.

The year 1941 witnessed the American pipe-line industry serenely handling its business with 132,000 miles of lines in service. The enormous demands of World War II for additional transportation of crude oil and products required not only the construction of new large lines, but also the operation of existing lines at remarkable new throughputs. This paper recites briefly the many noteworthy developments in pipe-line technology that made these feats possible and should provide operators with a useful list against which to check the state of development of their own systems.

The author is vice president of Shell Pipe Line Corp., Houston.

Improving Older Lines—Increased Line Capacities

SINKING or transfer of tankers during World War II forced immediate steps to increase capacities of existing lines. With but little new pipe and few prime movers or pumps available, we taxed our ingenuity for methods to raise throughputs with equipment on hand.

Looping lines. — An obvious first method was the old one of adding pipe loops to our trunk lines. Most of the pipe used was taken from abandoned lines or wells, or was purchased second or third-hand from junk dealers. Some of the loops were added as reserve crossings at rivers, thereby increasing line capacity not only in the orthodox way, but also through adding insurance against prolonged interruptions during flood-time breaks.

Pipe-resistance reductions. — Maintenance of pipe walls free of wax or other deposits received much attention. Our distinctive "go-devil" or scraper has been improved in many ways. Neoprene disks and wire brushes have replaced hard-rubber disks and knives. On the larger scrapers, life of disks has been increased by building them around a hollow air-tight cylinder for buoyancy and by drilling angular holes through them to cause rotation in transit. These holes also enable the oil slip streams to flush the debris ahead of the scraper.

Station capacity increases.—Station capacities were increased in many ways. In centrifugal pumps the casings were bored out, and the impellers were built up and rebalanced to raise deliveries 5 to 10 per cent. In reciprocating pumps the cylinders were fitted with oversize liners and plungers and—where possible—run at higher speeds. Motor-power outputs were stepped up far beyond normal ratings, and some engines were supercharged to develop the needed extra power.

Stream viscosity reductions.—By injecting field gasoline-plant products into crude-oil streams, the stream viscosities were lowered, with resultant higher daily throughputs at normal station pressures. Adding greater amounts of light products during winter months minimized the seasonal throughput decreases. Some crude streams regularly carried as much as 12 per cent of such "volatiles." Refiners benefited greatly because the light fractions were valuable in the manufacture of 100-octane gasoline.

*Chairman, A.P.I. Topical Committee on Pipe-Line Technology; assisted by J. E. Mims of Shell Pipe Line Corp., and suggestions by members of Topical Committee on Pipe-Line Technology.

Improved Customer Service

The war-accelerated quest for ways to better serve the customers has borne fruit in many ways.

"Closed" crude-oil lines.—The advantage of operating crude-oil lines without station float tanks is more and more realized. True, such operation in some instances has reduced their capacities as compared to the hoary practice of "putting and taking" into and out of station tanks before and behind each more-viscous batch of oil, but reductions of evaporation and interbatch contamination are attained as offsetting benefits. Batch interfaces can be readily followed through the lines by use of gravitometers or, in product lines, by visual color comparison. Crude-line slowdowns due to "closed" operation can be minimized by controlled blending or injection of "volatiles."

Field segregation and blending.—As an aid to refineries overtaxed by war demands, improved segregation of various crudes and the controlled blending of others close to their origins not only simplified distillation processes, but also reduced the number of refinery tanks required to assemble the several required charging stocks. . . .

Running direct to refinery topping units.—As another outcome of controlled blending in the fields, it was found practical to run the crude-oil streams from pipe line direct into the topping units. This practice also avoids evaporation losses of light or volatile-laden crudes from refinery stock tanks. Such line-to-still operation requires the pipe-line operator to keep the delivered stream uniform in quality and reasonably free from water. The refiner must be continuously informed of possible changes in stream composition. This is determined by locating at the pipe-line station immediately upstream such tell-tales as continuous vapor-pressure recorders, water detectors, automatic samplers and gravitometers.

Delivering products uncontaminated.—Advances have been made in reducing contamination or intermixing of adjacent batches in products lines. Further attention to choice of valve locations and elimination of dead spots has been found imperative. Some operators use synthetic-rubber plugs, water slugs, or neutral buffer stock between batches, but the trend is to discard these in favor of direct contact and keeping the stream moving above the "critical" velocity and under full line pressure at all times. Excellent results are being obtained by this technique. . . .

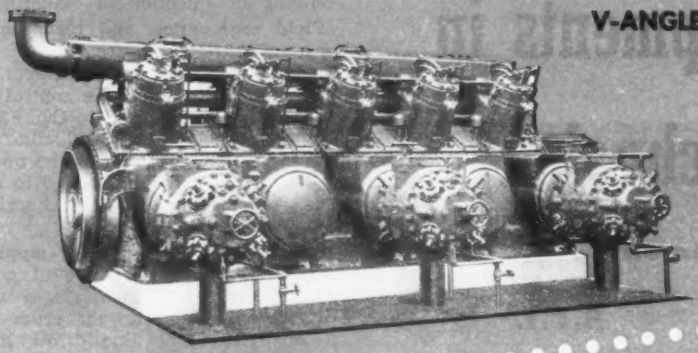
Blending ethyl fluid into gasoline streams. — Continuous blending of ethyl fluid into unleaded gasoline streams is another service performed by some products-line operators. . . .

Other Improved Operating Techniques

The pipe-line operator as well as his customers are better served by some of the practices just described. However, other techniques of most benefit to the operator also were developed.

Dispatching and communication advances. — The dispatching of many pipe-line systems has been simplified and expedited by the increased use of telephones and teletypewriters . . . Carrier currents superimposed on telephone or telegraph circuits are used to perform the new techniques known as "telemetering" and "telegaging," i.e., the long-distance transmission of pressures and other meterable characteristics. These are adapted to keep dispatchers constant-

(Continued on page 245)



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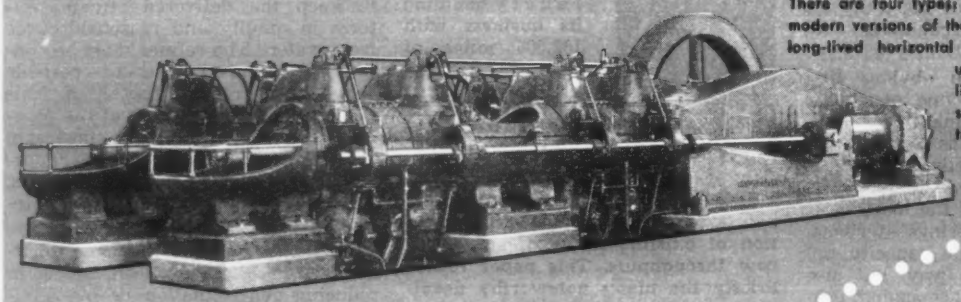

There are four types: 19, 22, 24 and 26, all modern versions of the slow speed, extremely long-lived horizontal gas engine. They are used primarily for main line compressor station service and gasoline extraction in large plants.

VERTICAL ENGINES
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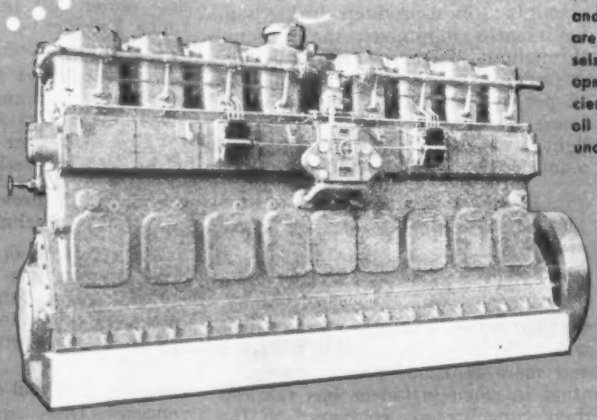
100 to 1800 bhp



In this group are in-line engines of many types and sizes for all general power purposes. Included are conventional spark-ignited gas engines, Diesels, and Cooper-Bessemer's revolutionary development, the gas-Diesel, offering full Diesel efficiency on gas fuel or any combination of gas and oil fuel, and permitting instantaneous conversion under full load.

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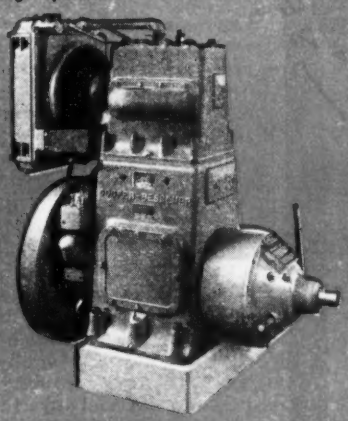
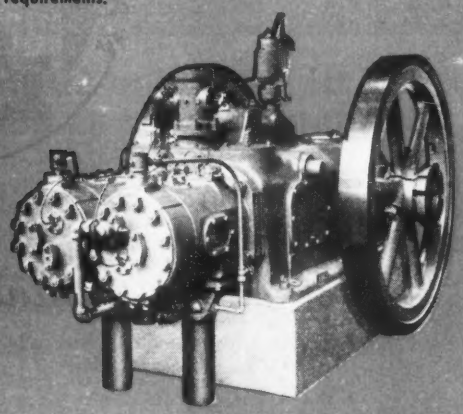


HORIZONTAL ENGINES GAS OR DIESEL 80 to 150 bhp

These dependable and economical engines are widely used for pumping, are equally well suited for compressor and generating service as well as other general power requirements.



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ly informed of pressures and flow rates at distant terminals, booster stations, or pressure-control points. Line breaks or other failures thus show up immediately in the dispatchers' offices as unreconciled pressure changes or as discrepancies between line receipts and deliveries.

Fluids meter advances. — "Closed" line operation, with its beneficial movement of volatile liquids, reduction of storage tanks, and minimizing of evaporation losses, requires that streams be metered. Abrasive foreign material in most crude-oil streams limits the use of positive-displacement meters, although improvements are being developed to overcome this handicap. Inferential (throat or orifice) meters of various types thus are used extensively on crude lines for control data. Positive-displacement meters are gaining wide acceptance on products lines and in marketing terminals, but they have been at a disadvantage due to lack of an accepted code of practice. The new tentative A.S.M.E.-A.P.I. Petroleum P.D. Meter Code, just now available for distribution, eliminates this deterrent. . . .

Automatic - station development.— With labor costs at an all-time high and the possibility of a shorter work week in sight, further development of unattended automatic booster stations moves ahead. . . .

Mobile pumping units.—Greater use is being made of mobile main-line pumping units . . . permits periodic overhaul of regular equipment, and fills the breach in emergencies. Permanent foundation slabs and manifold connections at each station enable unit transfers to be made with little time loss.

Tank-suction booster pumps.—Many oil-storage tanks worth a dollar per barrel of gross working capacity are reduced in efficiency by adverse topography, long suction lines, or high bubble point of the crude. Automatic electric-powered pumps, both centrifugal and axial-flow, now are available that can be installed to advantage in the suction lines at low cost and with little disturbance to the piping.

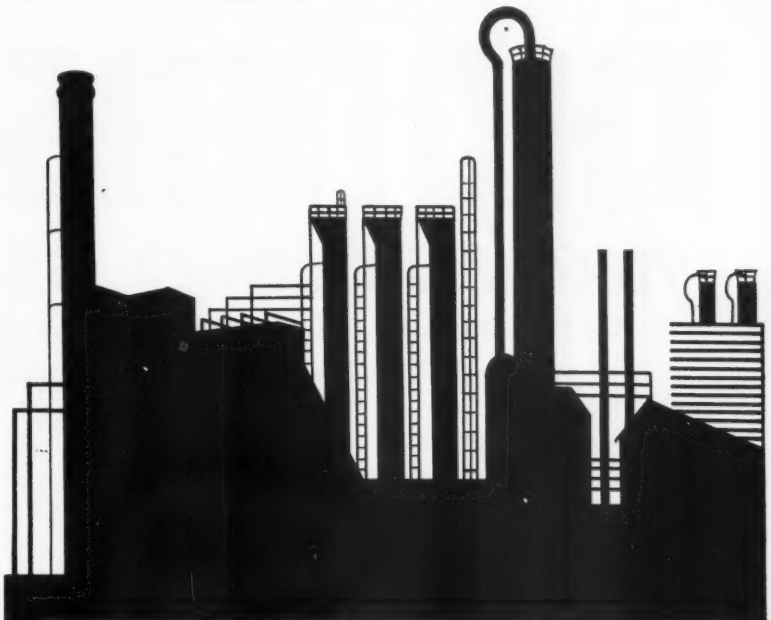
Engine-fuel improvement.—Use of run-of-stream crude oil as diesel-engine fuel in main-line stations is convenient. . . . Some operators are stopping such troubles by local "refining" of the crude to produce suitable fuel.

Gathering-system improvements.— . . . Main arteries are being made larger, laid to trunk-line specifications, and graded for gravity flow. Lateral lines are being designed of welded steel for sweet crude service, of cement-asbestos or cement-lined pipe for sour crude, and all with facilities for scraping when necessary. There is a general trend toward standardization of lease-tank battery headers and field pumping units. Use of time switches, interval timers, automatic tank shutoff valves, pressure flow regulators, and other controls on field pumping units serve to increase efficiency and reduce costs.

Better fire - fighting equipment.— . . . Recent developments of water fogs and other improved fire-fighting methods and equipment indicate that we should make a careful check of present facilities for efficiency and economy.

Improving Maintenance Methods

Air patrol.—Although the writer's oil company was the only one to use air patrol during the war (starting early in 1939 and flying with two planes about 16,000 miles regularly each month), postwar has witnessed wide acceptance of air patrols for detecting leaks, washouts, or line exposures along rights-of-way. Personnel transportation, mapping, construction, maintenance of telephone lines, and general inspections of line conditions also are simplified by use of airplanes. On weekly inspections of crude-oil trunk lines, one air-patrol plane can perform the job of about 25 line walkers for one-fourth of the cost (about 20 cents compared to 85 cents per mile). The patrols have proved equally effective in leak detection, with a decided advantage where they occur at river or creek



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crossings. Gathering-system patrols are not generally practicable because of their general layout and the presence of a maze of other lines.

On products lines the patrol has proved unsatisfactory for leak detection. Product leaks are difficult to observe from the air, besides which at large ones there is danger (caused by gasoline fumes in an explosive mixture with air) to planes flying above them at hedge-hopping altitudes. The airplane is useful on product lines, however, for periodic or special maintenance inspections.

Corrosion control.—Corrosion continues to be one of the industry's most serious problems. Many of the older trunk lines, badly deteriorated from soil corrosion, are being reconditioned and given new protective coatings supplemented with cathodic protection.

Gravity lines of steel pipe used for gathering in certain sour-crude fields on intermittent or low-velocity flow (less than 2½ ft. per second) have a normal life expectancy as short as 2 years. Frequent scraping to remove accumulated brine and primary corrosion products has more than doubled their service life. Use of cement-asbestos pipe in such service is increasing, one such line being in fine shape after 10 years of service. Cement-lined pipe should give more comparable service for higher pressures if the joints are properly sealed. Work is in progress to develop injected corrosion inhibitors for crude-oil lines, but the results cannot yet be appraised.

Products pipe lines have their own variety of internal corrosion. Data on very effective injected inhibitors have been widely publicized. Other measures, notably dehydration of product, have reached the stage of commercial use.

Internal corrosion of the upper parts of tanks by sour-oil vapors is receiving vigorous attention. Most of the war-developed lacquer surface finishes available carry a volatile solvent that leaves defects in the film when it evaporates. Several coats of the lacquer are necessary for a perfect seal. The "experts" say that to be successful the film must be produced by oxidation, polymerization, or condensation.

As to coatings for buried structures, many refinements in applications now give a better job than heretofore and assurance of almost complete protection for many years. In supplementary cathodic protection of trunk lines, the use of rectifiers is developing as the general practice. For protection of tank bottoms and shorter lines, sacrificial anodes of magnesium or zinc seem preferable; in fact, under favorable conditions they show a very low cost.

Line reconditioning.—This has become one of the largest, if not the most important, maintenance jobs of the industry. Many vital lines were laid 20 or 30 years ago when corrosion was not understood. The higher wartime line pressures caused numerous leaks and ruptures that disclosed the damage done to pipe walls by corrosion. Corrective measures are being taken at a rapid rate by many operators. Among the improved techniques recently found for this work is a "reclaimer" which in one rapid and continuous operation strips the earth from the line and forces the pipe to the surface without damaging it.

After a line has been raised, any of several methods may be used in reconditioning. Where damage is extensive, the pipe can best be removed to a central location for repair. Coating and wrapping may be done there or after the pipe has been tied back into the line. "Over the trench" reconditioning (with the line kept in service) is cheaper and faster. When badly damaged sections are replaced, the line, of course, must be shut down long enough to permit cutting out the damaged section and splicing in the new pipe. The equipment used in reconditioning is, generally speaking, not new; but many recent advances have been made to speed up and improve the quality of the jobs.

Emergency-line repairs.—To expedite emergency-line repairs, truck-

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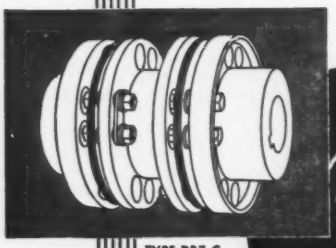
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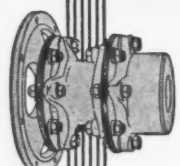
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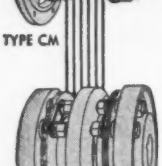
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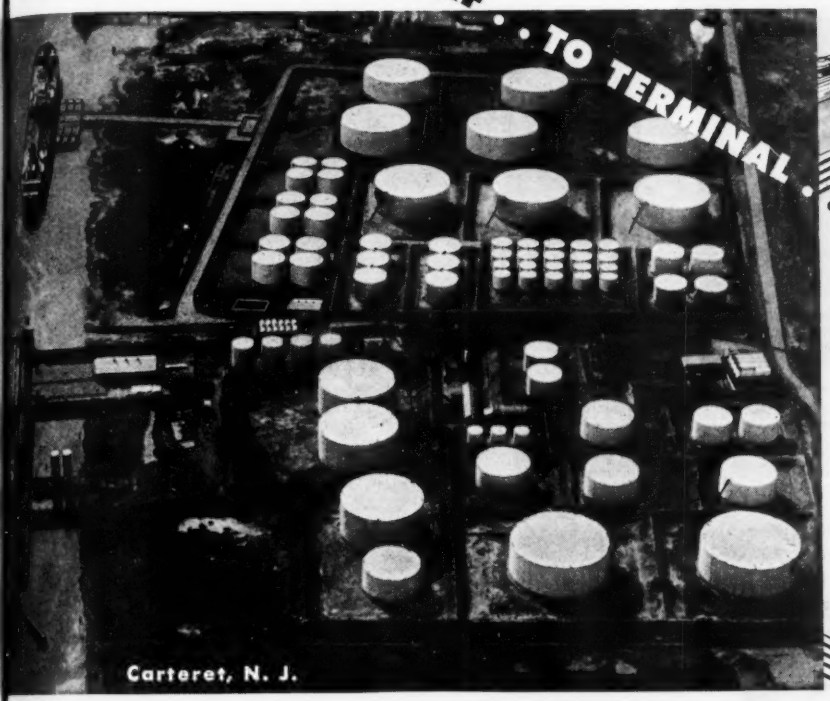

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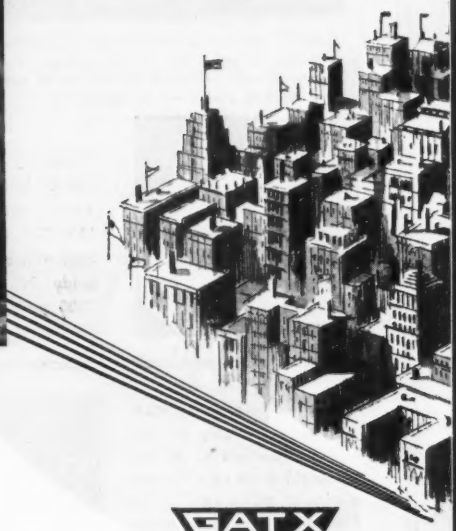

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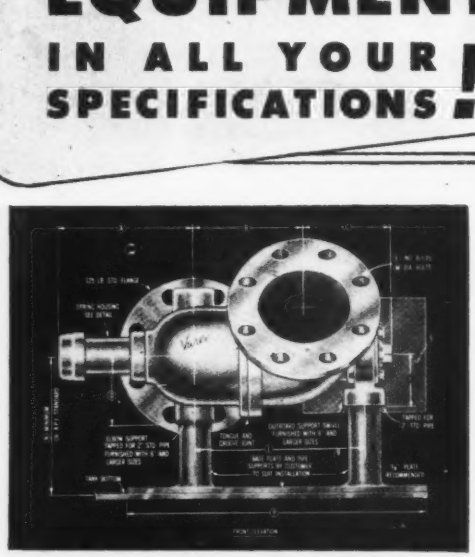

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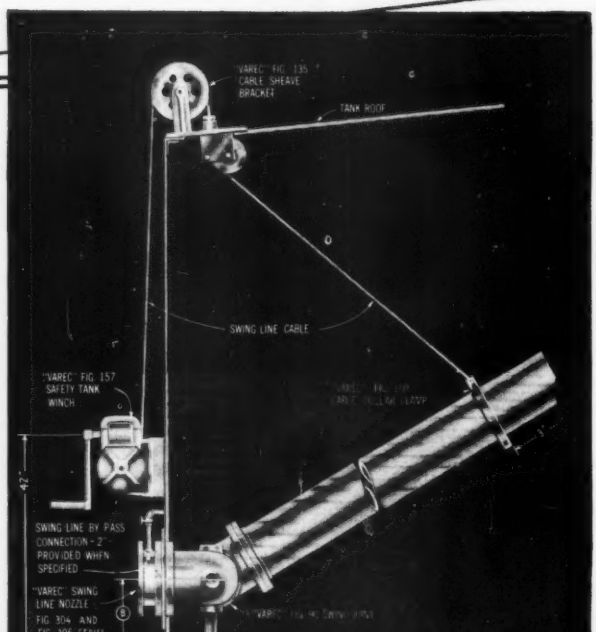
"VAREC" FIG. 135 CABLE SHEAVE BRACKET
TANK ROOF
SWING LINE CABLE
"VAREC" FIG. 157 SAFETY TANK WINCH
42"
SWING LINE BY PASS CONNECTION - 2" PROVIDED WHEN SPECIFIED
"VAREC" SWING LINE NOZZLE FIG. 304 AND FIG. 306 SERIES

"VAREC" approved SINGLE (illustrated) and DOUBLE SWING LINE ASSEMBLIES are made with extreme care to eliminate servicing of internal parts and to prevent failure of external parts if exposed to fire.

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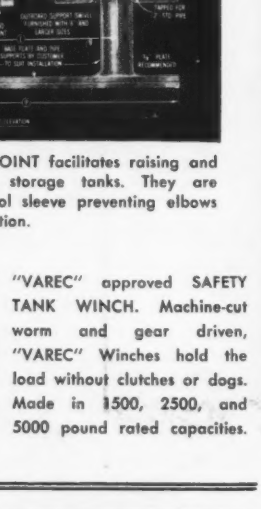

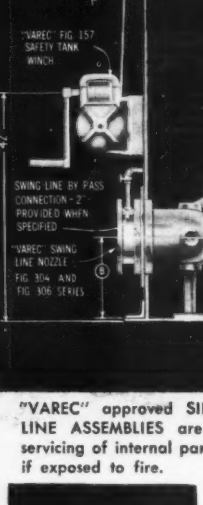

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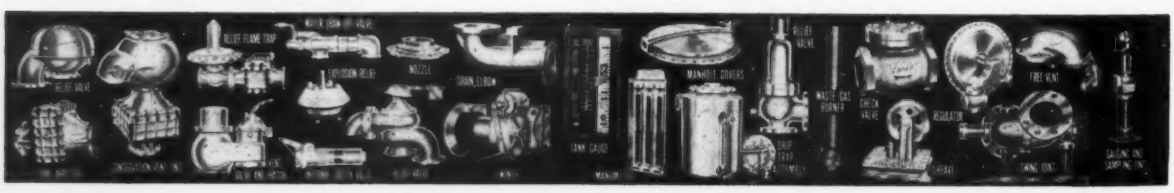

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mounted repair units, with all necessary tools or facilities, are being used to reduce labor costs as well as shutdown time and oil losses. Improved pipe-tapping and plugging devices increase the efficiency of making cuts in both crude and product lines. Avoiding need for mud or asphalt plugs reduces contamination. These devices are of ancient origin but of more recent popularity.

Machinery maintenance. — During the war, with little or no standby equipment in pumping stations, operating continuity records were established that reflect great credit to the maintenance personnel, and stand as an epic demonstration of their ingenuity. Much machinery and equipment downtime is caused by minor and easily correctible weaknesses. Consider, for instance, the conventional high-pressure plunger pump. Use of steel fluid ends stops the costly failures of cast iron. Light-weight alloy or micarta valves almost eliminate valve grinding and seat replacement. Packing and plunger replacements can be minimized by choice of plunger materials. Stainless steel (metalized on an iron base) or porcelain plungers wear 10 times as long as the best iron ones and show none of the characteristic grooving. . . .

Newer Construction Methods

In line construction the development of new methods, or the complete acceptance of older ones, is apparent.

Aerial surveys.—Use of aerial surveys to assist in the selection of pipeline routes is "old stuff" for those who could afford it, but it has since become a "poor boy's" method as well, because contact prints covering large sections of the United States now are available at nominal cost from the U. S. Agricultural Adjustment Administration in Washington.

Pressure welding. — "Pressure" or solid-phase welding has been used a great deal on recently laid lines. Speaking generally as to costs, arc welding is cheaper for pipe sizes up to 8 in.; costs are about the same for 10-in. pipe; and pressure welding is cheaper for larger sizes. The new technique is faster, and speed is a function of wall thickness rather than circumference. The joint strengths are as high or higher than the pipe wall if the welding is performed correctly.

Gamma-ray weld inspection.—One organization reports the use of a gamma-ray inspection to insure good-quality field welds. It is done by wrapping a sensitized film in a light-tight container around the outside of the weld and inserting a radioactive element centrally in the pipe behind it. After a 15-minute exposure, they are removed and a plug is welded into the small hole through which the element was inserted. The location, nature, and extent of weld imperfections show up clearly on the negatives and can at once be corrected.

Hydraulic line-up clamps.—The distortion of Big-Inch pipe in handling and stringing has led to the development of a clamp which forces the abutting walls into alignment, and thereby aids welding. Users claim a decided increase in speed of laying the larger lines . . .

Trends in New Line Design

Larger pipe diameters.—Experience has proved that it is more economical to obtain high throughputs by use of larger pipe than by increasing the number of stations or the line pressure: This is due partly to higher index costs of labor and machinery compared to costs of steel pipe. Even with the viscous crude oils of California, some operators are concluding that use of larger lines run at atmospheric temperatures are more economical than smaller ones in which the oil must be heated at each station. Thus, new and proposed lines of larger diameter are being designed with an eye to the future as well as the present. New lines probably will start operation at medium pressures or with extraordinary wide station spacing that will permit economical increases in pressure or number of

30 ANNIVERSARY

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stations to meet future needs. Increases in allowable fiber stress of steel line pipe through use of high-grade alloys and cold working has made this possible.

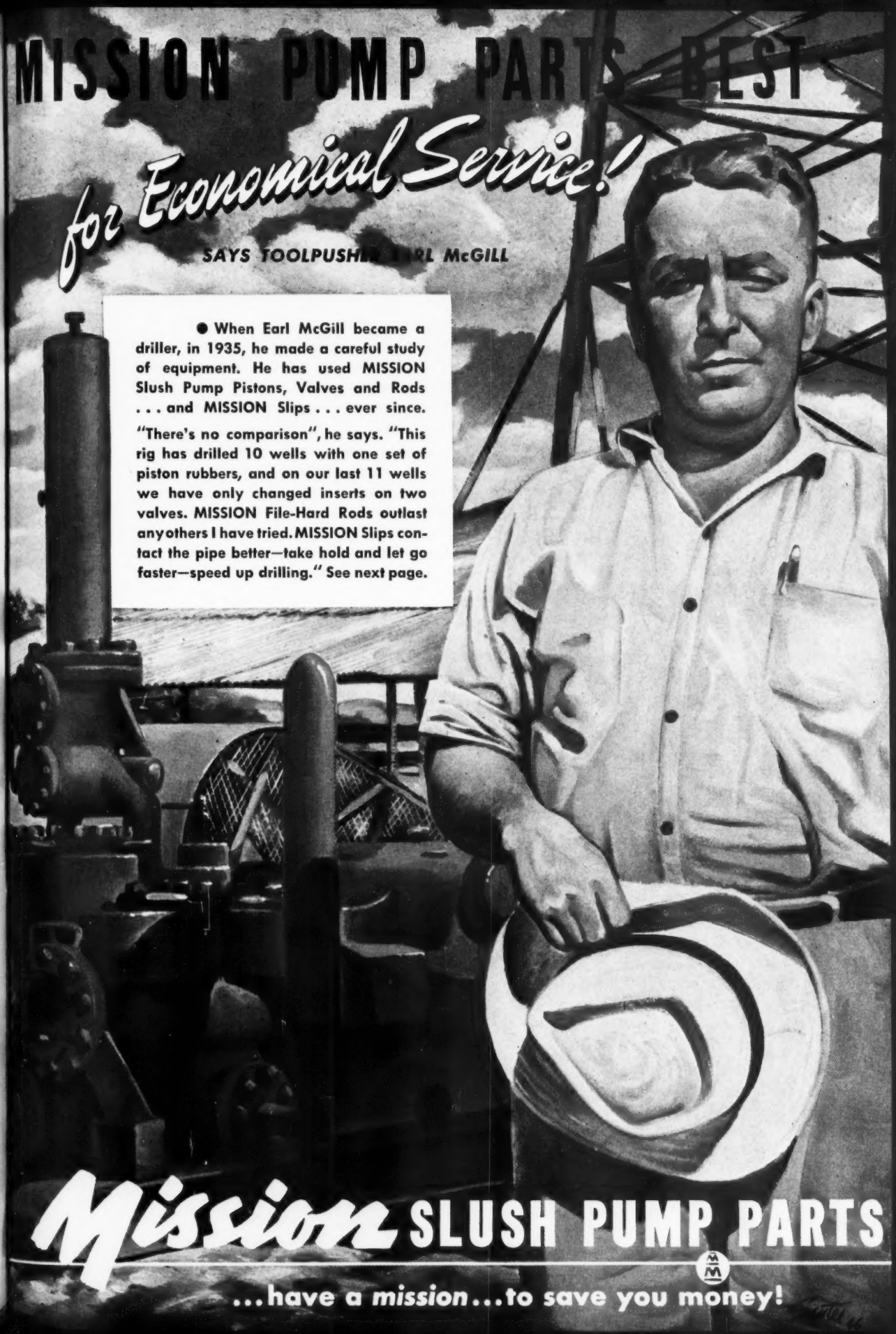
Thinner pipe walls and telescoping weights.—Improvements in pipe coatings and cathodic protection as a guard against soil corrosion, as well as higher strengths of the steel used, are permitting the use of thinner pipe walls. Nor do we need to use one wall thickness throughout a line because, by varying the wall thickness in proportion to the hydrostatic head, we can save on the steel cost and yet keep a reasonable factor of safety.

Larger pump sizes.—The increase in line size has required correspondingly greater pump capacities. The centrifugal pump has steadily gained popularity, even though it remains somewhat less efficient in energy consumption than the plunger pump. This popularity is due in part to low first cost and the special suitability of centrifugals for "closed" line operation. The old practice of connecting centrifugal pumps in parallel is now obsolete.

Improved pump design. — Higher-speed triplex and quintuplex pumps are in use by at least one operator. Prime advantages are compactness and reduction of line surges. New vertical variable-stroke pumps are proving popular. By automatic or manual control, the plunger stroke of these can be varied from zero to a maximum while the pump is in operation. Their design, in effect, combines the flexible-volume characteristics of a centrifugal pump with the high mechanical efficiency of the plunger type.

Engine-design trends.—Due to its flexibility and greater economy, diesel power still holds the advantage over electric power. Engine-design trends now, as in the past, are toward decreased weight-horsepower ratios and lower first cost. Increased reliability, compactness, operating economy, and ease of maintenance are prime objectives of the designers. The use of superchargers is increasing, and "dual-fuel" engines that run on various ratios of gas and oil are available. Closed cooling systems, usually shell-and-tube heat exchangers, are replacing the less economical open types.

Improved general-station design.—Piping manifolds are being placed aboveground to stop corrosion and make for accessibility. Station floors are being placed several feet above ground level to clear the manifold piping which is brought in through the floors to the pumps or instruments. Station buildings are being designed to perform their functions better. Noteworthy features are more convenient location of panels, engines, pumps, and auxiliary equipment; better ventilation and heating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systems; noise-reduction treatments; and provisions for greater personnel safety. Even better lighting and proper contrast of colors for eyestrain reduction are not overlooked.

River crossings.—For river crossings, more operators are using suspension bridges. For submerged lines the time-honored river "clamps" or weights are being abandoned in favor of welded sleeves to reinforce the pipe joints. Opinion varies as to whether buried river-crossing pipe should be coated, but the use of cathodic protection is general.

Speeded-up scraper handling.—Greater use of scrapers in large lines has brought innovations in scraper spool and trap design. Injection is aided by use of slightly larger-diameter spools. Traps, built long enough to hold several scrapers, avoid the need to remove each separately. Traps made in diameter several inches larger than the line, and with small pipes tack-welded internally to center the scraper, reduce sticking and aid removal. For convenience, good housekeeping, and safety, the traps and input spools are being placed aboveground.

Electrical equipment.—Electrical gear in pump stations has been steadily improved, and explosion-proof equipment is being installed almost entirely. The war forced the design of motors with less metal, but with no sacrifice in strength. Unitized transformer substations now allow for better circuit arrangement. Forced-draft cooling of these has enabled them to carry greater loads.

As a means of avoiding shutdowns of electric-driven pumps due to circuit-breaker kickouts caused by power-line surges during storms, a manufacturer and an operator have cooperated to develop a quick-acting relay that will reset the breaker within 20 cycles (⅓ sec.) of the kickout and before the motor slows down too much.

Free Enterprise

(Continued from page 239)

Pennsylvania, and Massachusetts—have barred the commercial servicing and fueling of motor vehicles within public parking areas authorized under their laws. A New Jersey law has established the same principle with respect to municipal bus terminals, although this enactment wisely permits individual bus companies to provide facilities to service their own vehicles.

The action of these states and of those which have made the same provision on limited-access highways are evidence of a pronounced trend. Through these enactments, the lawmakers of these states—and of the states I hope soon to follow their example—have shown themselves to be not only alert to the vital principles at stake, but also responsive to public opinion. . . .

Ours and Theirs

For however ardently the petroleum industry wants to keep the forces of free competition alive and energetic, however anxious it is to avoid the creation of monopolies in any form, however much importance it attributes to the survival and encouragement of small business, however eager it is to see our present war veterans come into their own in the world of enterprise, we could not feel more strongly on these subjects than the American people as a whole feel about them. Beyond a doubt, the opinion we hold on this subject is but an expression of public opinion; and our policy is neither more nor less than the policy expressed time and again by the American people whenever similar questions were put to them fairly and clearly. It is the policy on which our way of life was founded, and on which it is based today—and will forever be based—if our citizens are always truly informed of the facts.

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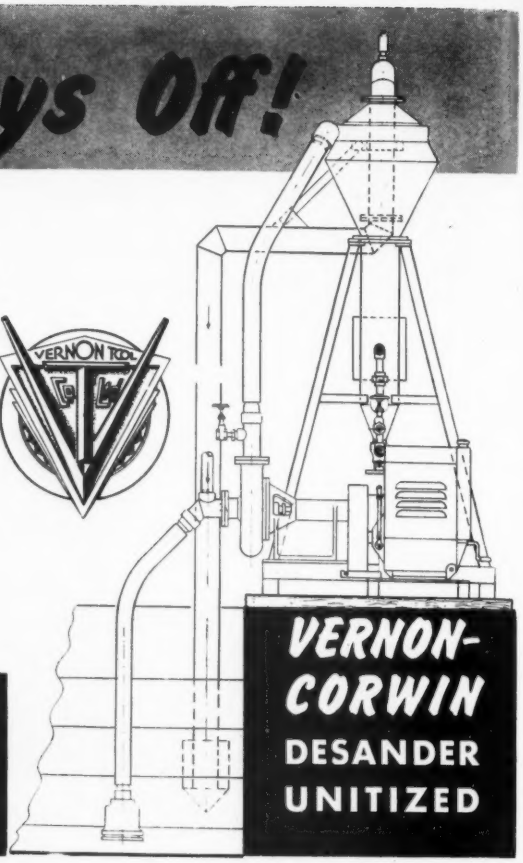

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Use of Corrosion Inhibitors In Products Pipe Lines

*by Ivy M. Parker**

THE practice of using corrosion inhibitors in products pipe lines during the past 10 years has saved the oil industry many thousands of dollars and enabled it to distribute the various refined products needed for wartime activity with a minimum of power and steel, because it has resulted in a general improvement of throughput and efficiency.

The use of internal inhibitors was initiated for two reasons: first, because of losses due to line fouling which reduced capacity and increased power consumption; second, because corrosion products carried by the stream were abrasive in close-clearance equipment. This resulted in pump and packing failures. These problems were discussed in detail in the 1943 A.P.I. symposium on combating internal corrosion of products pipe lines.[1] Of the 13 lines reporting at that time, 6 were using inhibitors; 2 had experienced no difficulties, and 5 had developed extensive scraper programs. In the present survey 20 companies were contacted, and of the 18 reporting, 12 use inhibitors; 3 are contemplating using an inhibitor; 1 dehydrates the products; 1 experiences no corrosion difficulties in any of its equipment or lines; and 1 did not indicate its position. One company uses an inhibitor in one of its lines, and depends on an extensive scraping program in others.

As emphasized in the 1943 symposium on products pipe lines, internal corrosion is associated with water and with oxygen. In this connection it can be considered in the light of atmospheric corrosion where experimental investigations[2] indicate that the primary cause is the actual dissolving of iron in water, which takes place before any other chemical action starts. A film of liquid water adhering to the metal is necessary. Oxygen acts as an accelerator by reacting with ferrous hydroxide and removing hydrogen. The pipe metal has the same tendency to adsorb moisture from the products as it would have to adsorb moisture from the atmosphere; and, although the gasoline does not have the same concentration of oxygen as found in the atmosphere, it still furnishes a continuous supply. In addition to the tendency of the metal to absorb a water film, the lighter products[3] permit a preferential wetting of the steel by water. The problem, then, is one of eliminating the water, the oxygen, or of inhibiting the reaction.

*Plantation Pipe Line Co., Atlanta. Presented at twenty-sixth annual meeting of the American Petroleum Institute. Of the tables accompanying the paper, only that of the "Summary" is given here.

A.P.I.

Mechanism of Inhibition

Briefly, the mechanism of inhibition involves building an impermeable membrane between the metal and the atmosphere or, in this case, the product containing dissolved oxygen. It has been shown that clean steel has an invisible iron-oxide[4] film, and that rust appears because the film is continually being broken and new permeable iron-oxide deposits are laid down. The purpose of the inhibitor is to repair these breaks with nonpermeable membranes. For example, with chromates[5] a mixture of hydrated ferric and chromic oxides is laid down which will not permit passage of corrosive agents. With nitrites[6] the action is probably one of building a straight ferric-oxide film. With mercaptobenzothiazole,[3] the inhibition action is probably due to the adsorption of a layer of the positively charged mercaptobenzothiazole radical in the steel which screens out the attacking elements.

The selection of an inhibitor involves an initial choice between a water-soluble material, an oil-soluble material, or a material that is distributed between the oil and water phase. The major portion of research in this field has been done by Phillips Petroleum Co., The Atlantic Refining Co., and Shell Oil Co., Inc.

Phillips and The Atlantic Refining Co. lines, being among the oldest, were the first to give trouble, and these companies were the first ones faced with developing internal inhibitors for products pipe lines. Both of these companies carried on extensive research and development programs.

Phillips[3] found residual treating fluids from refining operations causing a great deal of trouble in the refinery end of their line. Their investigation, covering the period 1934-1937, led them to the conclusion that the inhibitor: (1) Should be soluble in gasoline and slightly soluble in water; (2) should not lose its activity by reacting with any component of the gasoline; (3) must not alter the properties of the gasoline; and (4) must possess an affinity for metals. From a study of several hundred compounds, mercaptobenzothiazole was chosen as the most effective, and it was put into field application in February 1937 by Phillips Petroleum Co.

The Buffalo-Keystone Pipe Line,* operated by The Atlantic Refining Co., studied the suitability of sodium chromate, a water-soluble inhibitor. Their program consisted of laboratory beaker tests, ½-in. pilot pipe line, and field-test spools, in addition to rather exhaustive testing of effect of chro-

TABLE 1—SUMMARY

Company	Products	Inhibitor	Miles	Duration of program	C factor (modified Hazen and Williams formula) Start	Average	Maximum	Minimum
L	Gasoline, kerosene, and fuel oils	Mercaptobenzothiazole	700	3 years	No data given			
I	Butane, gasoline, kerosene and distillates	Mercaptobenzothiazole	1,053	6 mo. to 9 yr.	100	138	140	136
O	Gasoline, kerosene, and fuel oils	Sodium chromate	50	2 months	90	130	140	110
Q	100-octane aviation, through fuel oils	Sodium chromate	1,475	14 months	140	...	†150	...
E	Condensate	Sodium chromate	37.5	21 months	128	142	145	141
G	Gasoline, kerosene, furnace oils, diesel, fuel	Sodium chromate	815	11 years	120-125	155-160	165	150
F	Housebrand, premium, 91 and 100-octane gasoline	Sodium nitrite	No data given	Program just starting	...	...	...	...
T	Gasoline and kerosene	Sodium nitrite	465	1½ years	130	150	158	147
A	Gasoline, kerosene, No. 2 fuel oil	Sodium nitrite	265	3½ years	Old pipe, not significant	155	...	...
J	Gasoline, kerosene, fuel oils	Sodium nitrite	1,261	4 years	142	*161	162	159
D	Gasoline, furnace oil	Sodium nitrite†	2,000	10 years	130	150	155	140
K	Propane to fuel oil	Sodium nitrite	900	7 years	125	155-160	160	155

* Data on main line only. †1936-1941 sodium sulfite, and 1942 to date sodium nitrite.

mate on the various refined petroleum products. The Buffalo-Keystone system initiated their field program in April 1935. Most companies which are using, or have used, chromate have done so on the basis of this work and operational experience.

The Shell company experienced internal pipe-line corrosion soon after it had built its products lines. It carried out an extensive research program[8] which resulted in the choice of sodium nitrite as the outstanding material for application to the products pipe lines. It found that the nitrite did not affect, and was not affected by, any of the products. Shell developed the patented field application of sodium nitrite as an internal corrosion inhibitor in products pipe lines, and has licensed and supplied technical advice to all of the users of sodium nitrite as a products pipe-line inhibitor.

In applying inhibitors, it is necessary to reconsider their function—that of repairing breaks in the iron-oxide film. In general, it has been considered advisable to inject the inhibitor continuously, because film breaks are inevitable. Replies to our questionnaire show that the users (A, D, F, J, K, and T) of sodium nitrite all use the gravity feeder as equipment for injecting the solution. The users (E, G, O, and Q) of chromate employ proportioning pumps. The inhibitor injection is controlled by concentration in the effluent water. One user (I) of mercaptobenzothiazole uses intermittent feed, and the other (L) feeds continuously. Both use automatic proportioning pumps for injectors.

The replies to the questionnaire indicate that all companies have determined, after extensive tests, that the inhibitors used do not materially affect the products pumped.

There is some confusion in the answers concerning precautions, both in regard to handling the chemicals and disposition of the effluent water. It should be emphasized that each of these chemicals is somewhat toxic, and should be handled with special safety precautions and respect. The toxic nature of the water withdrawn from the lines using these inhibitors requires that care be exercised in the disposal of the effluent.

Maximum Carrying Distances

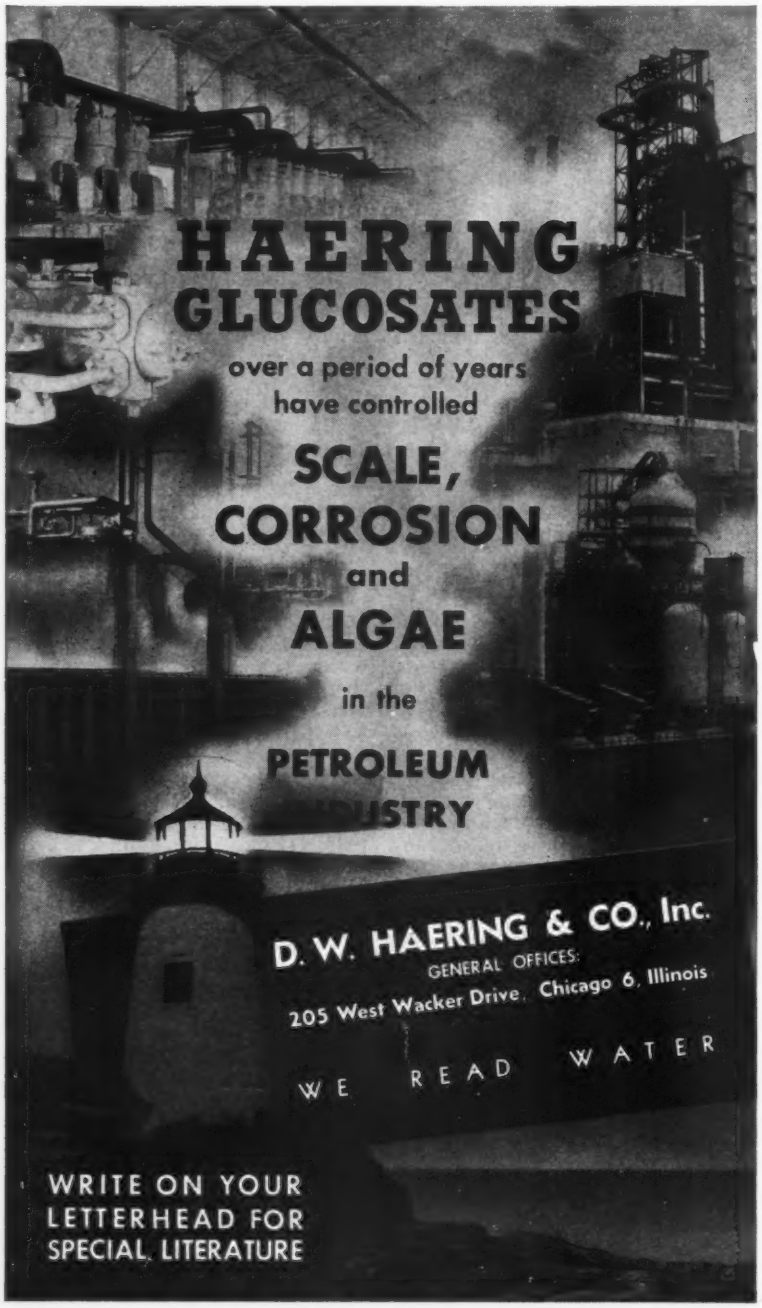
Some study and attention has been directed toward determining the maximum carrying distances of the various inhibitors. However, it has been found convenient and feasible to alter the amount and concentration of inhibitors to accommodate varying distances between pump stations rather than establish injection points at remote regularly spaced points on the pipe lines. The practice of withdrawing the water at pumping stations removes the unreacted water-soluble inhibitors. Coupon data have been used to determine the injection points for the oil-soluble inhibitor.

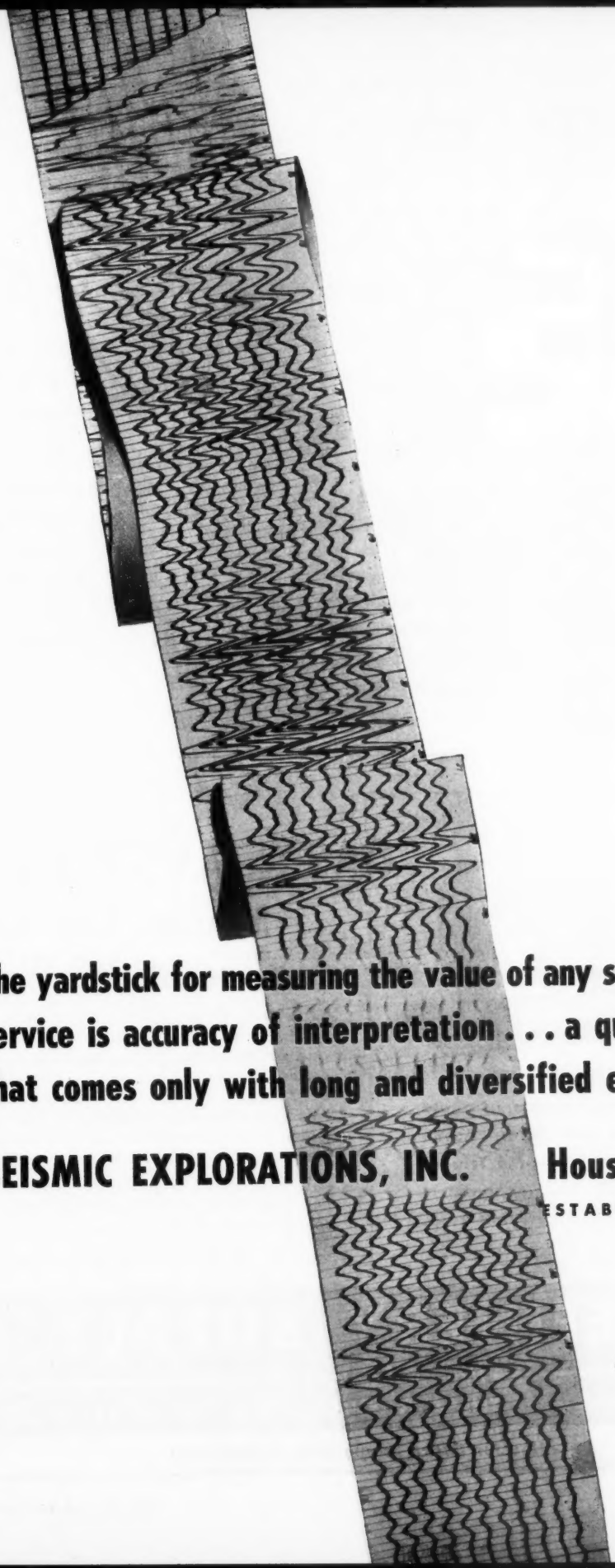
One factor not brought out in the questionnaire is that all users of corrosion inhibitors in products pipe lines use caustic soda or sodium carbonate to adjust the effluent water drawn off downstream to a pH of 7 or above. After lines have been inhibited for a number of years, some of the operators find that the amount of alkaline material required is greatly reduced.

All lines using inhibitors and/or scrapers have provisions for removing water and scale through hay tanks, sediment traps, or settling tanks.

Under the heading "use of mechanical aids," we have a variety of opinions. With the exception of companies G, O, and I, the scraper runs are considered effective from 40 to 100 miles. The condition of the line and design of the scraper undoubtedly have considerable bearing on length of effective scraper runs. Replies received show that, where inhibitors are used, the general opinion in the industry is that the primary purpose of the scraper is to remove water and sediment.

It is well to point out that almost every company, regardless of inhibi-





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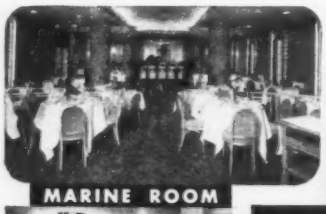

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tor being used, has found it advisable when initiating the inhibitor program to use heavy doses of chemical and to carry out an intensive scraping program. This was brought out in the 1943 symposium. Some of the reasons for this are: (1) Inhibitor has to be distributed throughout the line; (2) the old rust absorbs and consumes the inhibitor; (3) as the corrosion activity is stifled, the tubercles and rust lose the bonding effect occurring from corrosion activity, and tend to slough off. The scraper program hastens the removal of this material and at the same time may help spread the inhibitor. A point not brought out in the questionnaire is that, after lines have been cleaned up, some operators[11] find it unnecessary to run scrapers.

Good Internal Conditions Reported

All of the pipe lines that have an established inhibitor program report good internal pipe conditions. Several operators who have recently started programs have not had time to accumulate significant data. Six of these lines had scraper programs prior to starting their inhibitor programs. Two companies, C and E (except one line) state that, with regular scraping programs, they have been able to maintain a good C factor, but they do not give any data on the conditions of their line. Company H has not experienced any corrosion difficulties, and states that the pipe is in excellent condition. Although no data were collected on the quantity of scale removed from the various lines, it is most probable that under corrosive conditions those lines using scrapers alone are suffering a greater metal loss than those using inhibitors. The "cost per barrel-mile" figures were not tabulated because the data received were not comparable, and there was not time to obtain additional data.

The inhibitor practices and C factors, as expressed by the modified Hazen and Williams formula, are summarized in Table 1. Two companies use mercaptobenzothiazole in a total of 1,753 miles of pipe; four companies use sodium chromate in 2,377.5 miles; six use sodium nitrite in 4,891 miles of pipe, and one company is preparing to use nitrite.

The average C factors before the inhibitor program was started had ranged from 90 to 142, and they have been increased to from 130 to 161. It was brought out in the 1943 symposium that an increase of 10 points in C factor represents about 7 per cent increase in throughput without increase in power. Using this criterion, it can be safely stated that an improvement of 10 to 15 per cent has been achieved.

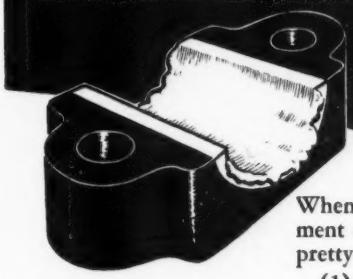
Acknowledgment

The author is indebted to the 18 companies contacted for answering the questionnaire very promptly and for supplying the data presented in this paper. This courtesy is greatly appreciated.

References

1. Proc. A.P.I. 24 (IV) 39-135 (1943).
2. J. F. G. Hicks, "Physico-Chemical Causes of Corrosion," J. Phys. Chem. 33, 780 (1929).
3. J. M. Pearson, "Combating Internal Corrosion," Proc. A.P.I. 24 (IV) 67 (1943).
4. U. R. Evans, Metallic Corrosion, Passivity, and Protection, 1, Longmans Green & Co., New York (1946).
5. T. P. Hoar and U. R. Evans, "The Passivity of Metals—VII: The Specific Function of Chromates," J. Chem. Soc., 2476, (1932).
6. A. Wachter and S. S. Smith, "Preventing Internal Corrosion of Pipe Lines," Ind. Eng. Chem. 35, 358-67 (1943).
7. A. V. Soloviev, "Electrochemical Investigation of the Anticorrosive Properties of Sodium Nitrite," Comp. rend. acad. Sci. U.R.S.S. 14, 295-8 (in English) (1937).
8. Charles A. Mann, "Organic Inhibitors of Corrosion," Trans. Electrochem. Soc. 69 115-29 (1936).
9. L. C. Morris and W. A. Schulze, "Internal Corrosion of Gasoline Pipe Lines," The Oil and Gas Journal 38 (27) 205 (1939).
10. H. G. Schad, "Symposium on Combating Internal Corrosion of Products Pipe Lines: Keystone-Buffalo Pipe Line System," 24 (IV) 44 (1943).
11. S. S. Smith and R. K. Schulze, "Internal Corrosion of Products Pipe Lines: The Use of Sodium-Nitrite Inhibitor in Gasoline Pipe Lines," Proc. A.P.I. 24 (IV) 91 (1946).
12. Proc. A.P.I. 24 (IV) 57 and 102 (1943).

WHEN BEARINGS SQUEEZE OUT



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Practical Aspects of

DIRECTIONAL DRILLING

by D. K. Weaver

A.P.I.

Directional drilling of rotary holes has become common practice in the oil fields, with recognition of the savings to be made by exploiting additional reserves in locations too costly or inaccessible for vertical drilling. In limited use in the Signal Hill field from about 1927 to 1930, real development of high-angle directional drilling occurred during 1938 with the tapping of the rich oil pool lying beneath the tidelands off Huntington Beach, Orange County, California. This paper gives the practical side of directional drilling with control methods other than with deflecting tools.

The author is with Wilshire Oil Co., Norwalk, Calif., and Coast Line Drilling Co., Inglewood, Calif.

TO run primary tools such as a whipstock, it is necessary to condition the hole, drill by the whipstock, drill ahead with rathole bit; and, finally, expand the hole to full size if results are as desired. This may involve three or four extra roundtrips. Under some conditions two of these trips can be eliminated by using a differential bit in place of a hole opener. This type of bit, if crowded (i.e., forced by the application of sufficient weight), will follow closely the rathole—thus expanding the hole to full gage and permitting continued drilling without changing the bit.

Considerable time lost by earlier methods is now saved by the use of the full-gage whipstock, full-gage knuckle joint, and the self-orienting drift master.[1] Bottom orientation by various methods has greatly reduced the time of running primary tools, whereas the non-magnetic drill collar has likewise reduced time of taking directional single shots.

Obviously, advantage of directional drilling is the ability to direct the well bore along a predetermined course to a desired objective using the minimum number of primary tools. A great deal of knowledge and experience have been gained during the past 15 years concerning the results of using various combinations of drill-pipe and drill-collar sizes, use of reamers, types of bits, combinations of weight on bit, pump pressure, and rotary-table speed. The following is written in the hope that it will help the industry attain maximum drilling speed and avoid many of the mistakes commonly made by some oil producers when they first undertake directional ventures in their own operations.

Once a company has decided to drill a directional hole, the first step is to draw a horizontal and vertical plan of the course to be followed. Proper initial planning is essential. The company should keep in mind that the hole must not only be drilled, but must be cased; and later the well must be produced by mechanical means. Usually the position of the finishing depth in the oil zone is plotted as a point with reference to the surface location. In some cases the point of entry to the producing zone is given, as well as the finishing point. This, then, determines the finishing direction and angle of hole. A graphical means of preparing the vertical plan is to increase the angle of the hole at 3° per 100 ft., or greater

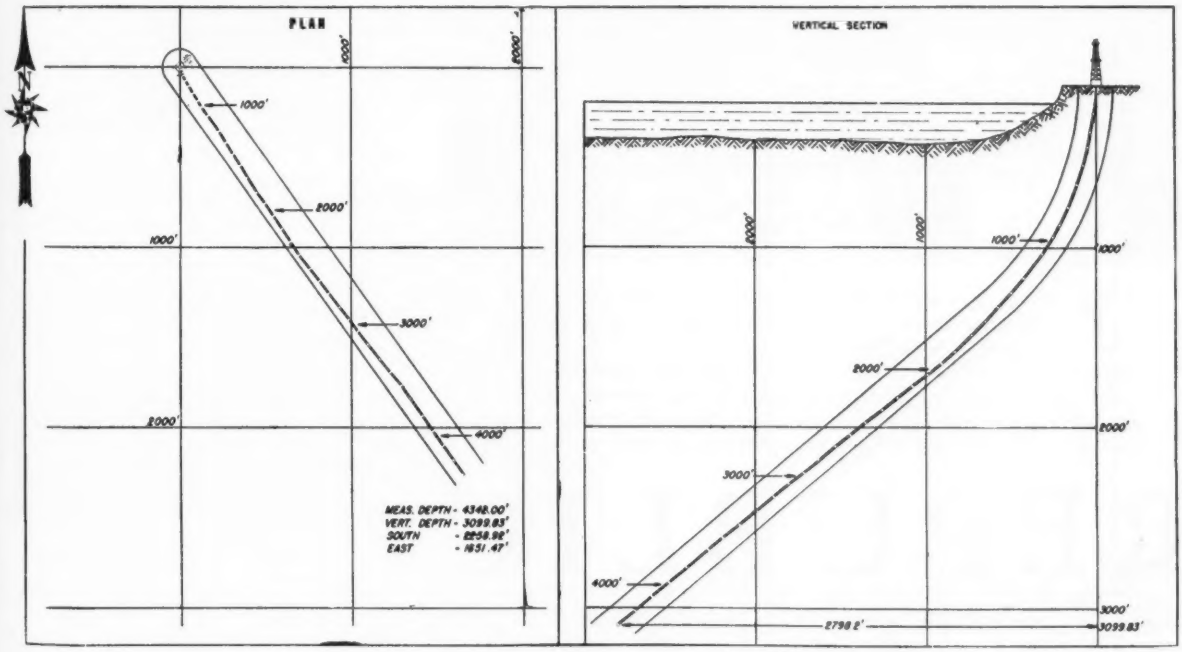

Fig. 1—Horizontal and vertical plan for cylinder drilling

if necessary, until the angle has increased sufficiently to be extended in a straight line and intersect the objective. It is preferable that, when possible, at least the top 150 to 200 ft. of the hole be vertical. Directional work is then planned to start in the first satisfactory geological formation below this depth, usually the first firm or consolidated shale body.

An operator may desire to drill many directional wells with a definite well-spacing program, or he may be required to place wells between other directional holes already drilled In this instance cylinder drilling calling for close control, is advantageous. This practice is common in California—and the plan shows a cylinder of predetermined radius with proposed course as the center line. At periodic intervals circles are drawn to represent the cylinder in cross-section. The position of the actual bore can then be plotted at the various levels, showing relation to the center of the cylinder. With this type of drilling, wells have been drilled in a line at Huntington Beach with as little as 30 in. between surface-well centers. With a track, one derrick on wheels can service five or six such wells.

In planning a course it is necessary to fit the directional work into the geological horizon which will permit this type of drilling. Some extremely hard, homogeneous formations would not lend themselves to building angle or a change of direction. However, the course and angle may be maintained if the bore is already on proper course at the time of encountering such formations.

Some of the early wells directionally drilled were deflected from the surface by tilting the rotary table with a 2 to 3-in. block and tying the kelly over to the opposite side. This gave so much trouble in setting the slips when coming in and out of the hole, and later threw such a strain on the surface pumping equipment, that the plan was abandoned in favor of drilling the first few hundred feet vertically.[3] Also, excessive wear occurred at the shoe of the surface pipe which caused many failures. An extra-heavy shoe on the surface pipe is recommended on all occasions.

At Huntington Beach, as the first 700 ft. of formation is unconsolidated sand and gravel, surface pipe is set about 50 ft. into the first shale. Directional work usually is started about 30 ft. below the shoe of the surface pipe. Starting at this depth, the angle is increased from the first whipstock 2½° to 3° per 100 ft., until the angle has reached that determined for the finishing depth in the oil zone. The balance of the course then can be straight, maintaining the same angle to bottom. This results in a smooth curve changing tangentially to a straight line which, experience has proved, is easily drilled, easily cased, and results in a minimum of difficulty after the well is placed on the pump (see Fig. 1; example of horizontal and vertical plan).

Initial Deflection

Proper choice and setting of the first deflecting tool is important, inasmuch as an incorrect starting direction may require two or more settings to remedy. If the formation is firm, an oriented whipstock is desirable for the initial takeoff. In soft formations a spudding bit works very satisfactorily, either in making the initial deflection from drilled bottom or in drilling off a cement plug. This is a wedge-shaped bit with the back side shaped like the back of a spoon. It is run on a kinked or straight double of drill pipe, and is oriented into the hole and spudded until 2 to 4 ft. of hole have been made—the shape of the bit carrying the hole to the side in the desired direction. Formerly a double of the next smaller size drill pipe with a rathole bit was then run in to make the follow-up hole, which was expanded with hole opener in the usual manner. Spudding bits are now more commonly used as a means of accentuating results from

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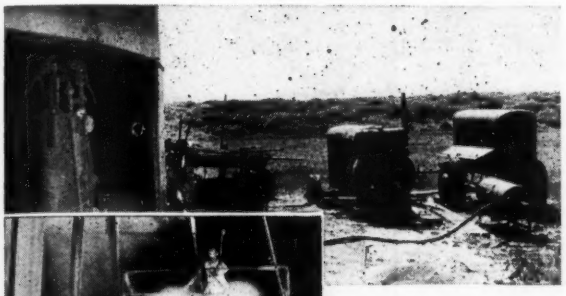

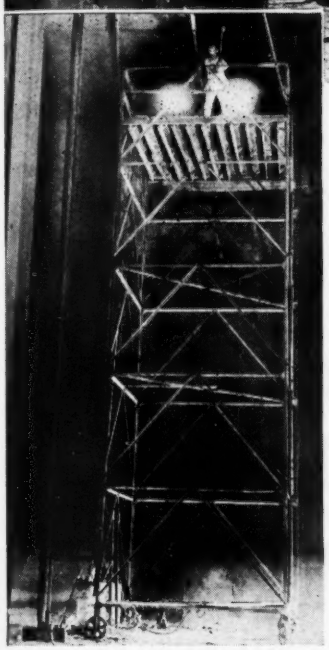

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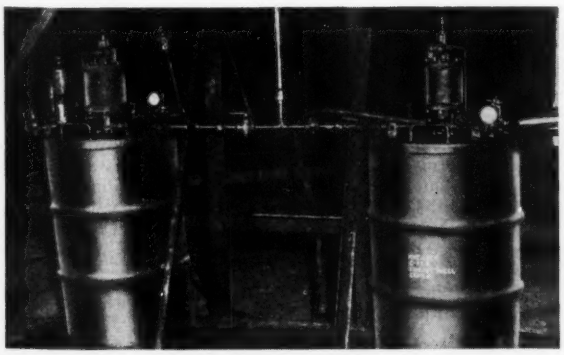

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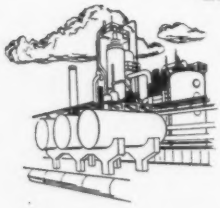

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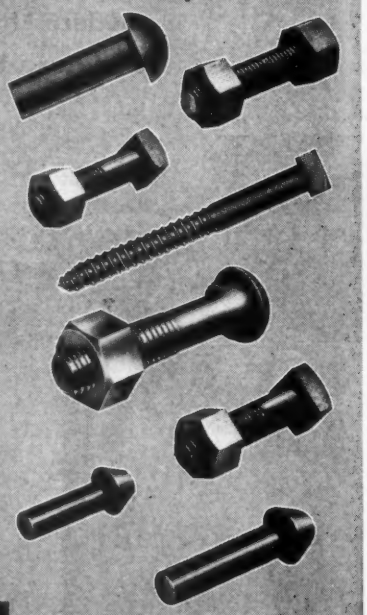

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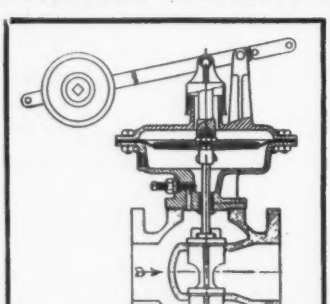

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other primary deflecting tools or to aid in sidetracking.

Initial deflection also may be obtained by using the eccentric turbine bit, run on a kinked double of drill pipe or a short length of the preflexed drill pipe used with this bit in drilling drain holes. Probably 5 or 6 ft. of the hole would be sufficient with this combination, which has the advantage that the drill pipe does not rotate once the orientation is made. Bottom-hole orientation, in common use in the Mid-Continent, soon should replace the oriented drill-pipe method.

One of the important considerations in drilling a directional hole is the geology of the local area to be penetrated. A knowledge of the type of sediments and the direction of dip is all-important. In general, directional drilling can be done without excessive cost in most sedimentary rocks where the formations are not too steeply tilted nor too hard.

Most bore holes, when given sufficient weight on the bit, tend to climb updip after the angle exceeds 4°. Below that angle there is little control of direction, as the hole usually spirals in a clockwise direction—probably influenced by the direction of rotation of the drill. Considerable influence is exerted by alternating hard and soft beds—especially where dips exceed 20° to 25°—and direction will vary depending on whether the course is updip, along strike, or downdip.

As soon as a bore has reached an angle of 5° to 6° from vertical, the tendency of the drill is to go in a relatively straight course if going updip, whereas it will usually pull right or clockwise if going downdip. If the course is along the strike, the hole will tend to go downdip. These factors should be considered in making the initial settings with the primary deflecting tools. In other words, if a right pull is expected, a primary setting up to 15° to the left of the desired course should be used. If an initial angle of 2½° to 3° is obtained from the first primary run, this practice allows the drilling ahead with combinations for increasing angle, until the rightpull has taken the hole to the true desired course. To avoid overswing, another primary tool, set from 3° to 5° left of course, should take the drift angle above 6°, where the hole will tend to take off and maintain the desired predetermined course. The 3° to 5° left setting should compensate for any remaining right pull. If an overswing occurs, it may take two or three more primary tool settings to achieve that which would have been accomplished by one set at the right time.

To obtain the maximum results from the initial deflecting tool, an open-hole-single-shot picture should first be taken. If the hole is exactly vertical, the setting can be made at

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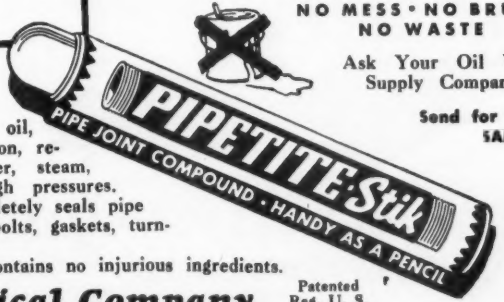

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once. If there is ½° to 1° deflection in the wrong quadrant from the desired start, a little additional drilling with the clockwise-spiralling tendency usually will put the hole in the desired quadrant, where maximum results can be obtained from the initial deflection. This practice naturally requires some leniency from the takeoff point originally planned.

Results of Various Combinations

Once the primary tools have given the initial deflection in the desired direction, the next requirement in directional drilling is to build angle (i.e., to increase the angle). This operation is simple, and the acceleration of angle is usually easily controlled. At this time all necessary tools should be on the rig. In addition to the survey instruments for both open-hole and wire-line single shots, there should be 8 and 12-ft. drill collars made with pin and box, in order to make up combinations for 8, 12 and 20 ft. of drill collars. In addition, there should be one 40-ft. drill collar. Full-size reamers with helical cutters—preferably sharp—are used directly above the bit, whereas slightly undersized reamers for stabilizers with half-flat helical cutters are used above the drill collars, when required. Thus, if the bottom reamer is 10⅝ in., a 9⅝-in. stabilizing reamer is used above; and, if a 12¼-in. bottom reamer is used, a 10⅝-in. stabilizer is used. A complete selection of bits should be available, including drag and rock-type heads.

The first requisite for building angle is a reamer, placed just above the bit, or with a short sub between. With ample weight on bottom the reamer then becomes a fulcrum, prying the bit gradually upward. The reamer should have helical-type cutters, as these are the only design that will turn and not run a flat in a slant hole.

It is possible to build angle at a greatly varied rate by using drill collars of different lengths or no drill collar at all. The rate of change in the angle of 4° per 100 ft. is about the maximum desired for the average directional hole, and for this rate an 8 to 12-ft. drill collar is usually satisfactory. Sufficient weight must be carried to keep the reamer prying the bit upward. At the same time the table speed should be slow, and only sufficient pump pressure used to insure adequate cleaning of the bit and reamer. Too much circulation in soft formations will wash a cavity which may cause the hole to drop angle (i.e., to decrease the angle).

A generalized tabulation is shown hereinafter for angle control, which may be a guide to the operator.

Another method for angle building is to use the usual bit and reamers on bottom, then a 12 to 15-ft. joint of drill pipe above the reamer, and 80 ft. of drill collars above the short joint of drill pipe. This assembly can be rotated up to 150 r.p.m. with only about 2 tons of weight, and will build angle as rapidly as 4° to 5° per 100 ft.

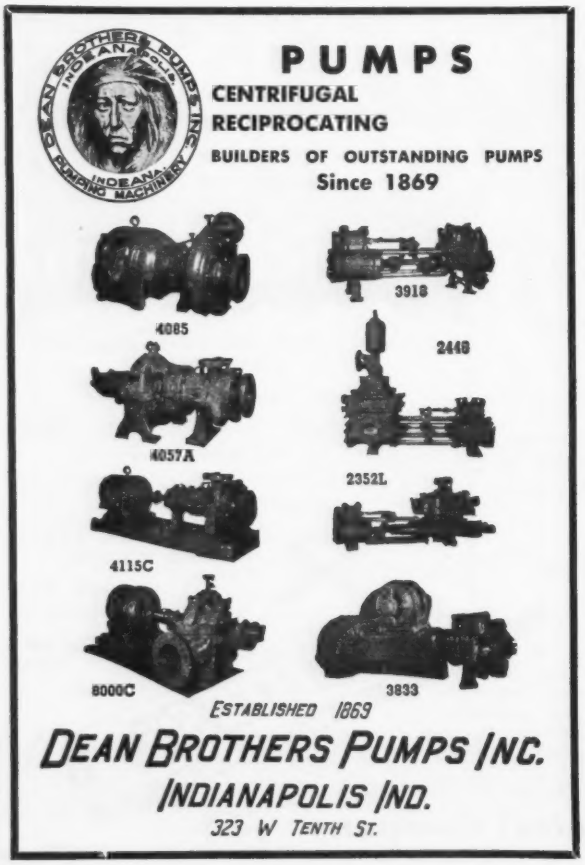
70 R.P.M.—8 TONS WEIGHT—4½-IN. DRILL PIPE—10⅝ TO 11½-IN. HOLE

Increase per 100 ft. (deg.)	Drill collar, if any, with reamer below (ft.)
0-½	80-120
½-1	40
1-2	30
2-3	20
3-5	8-12
5-7	(*)
7 plus	(†)

*No drill collar. †No drill collar and 3½-in. double.

It must be kept in mind, where tons of weight on the bit are mentioned, that this is in the initial angle-building procedure. As the angle in the hole increases, wall friction absorbs more and more of the weight shown on the weight indicator. In drilling a hole with angle up to 50° or 60°, the indicator weight carried on bottom may be as high as 12 to 15 tons in order to have 7 to 8 effective tons on the bit itself.

It can be seen that a wide variation in increase of deflection is possible merely by lengthening or shortening the drill collar, increasing or



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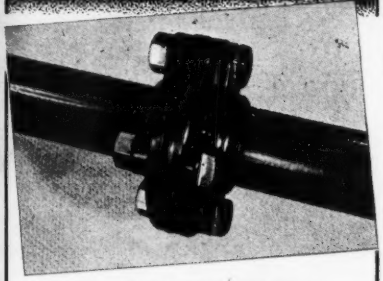

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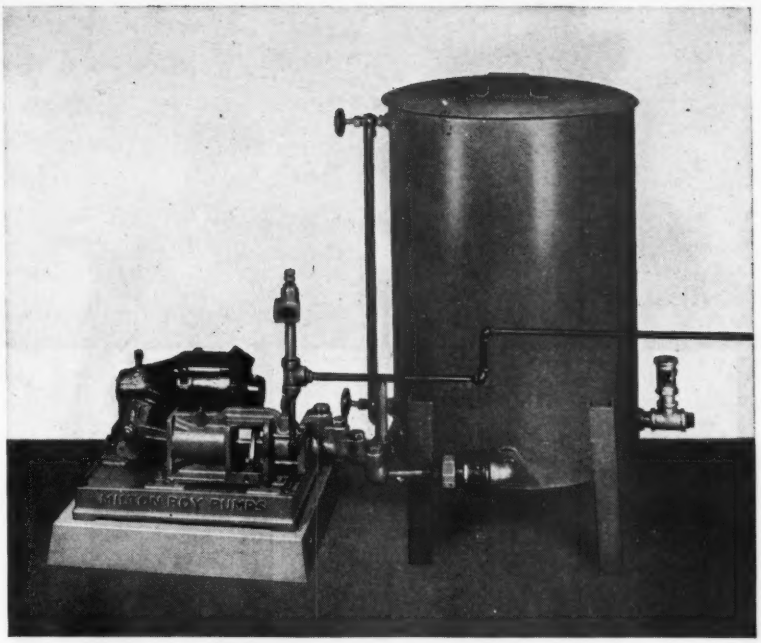

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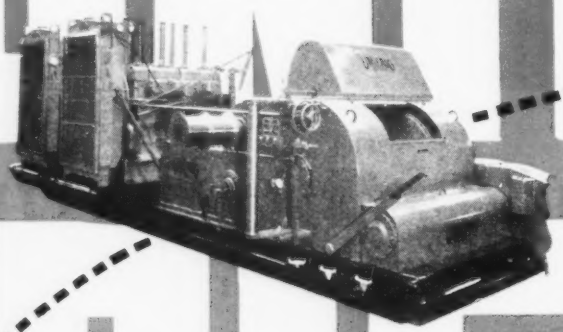

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decreasing the weight on bottom, and increasing or decreasing the table speed. Whatever combination is used, it must be remembered that sufficient weight on the bit and slow table speed are necessary. High speed of rotation and 2 to 3 tons of weight will cause a hole to drop angle immediately.

Hardness of the formations, as well as the direction of dip, causes quite a variation in these combinations. If, for example, with an 8-ft. drill collar, reamer below, 7 tons of weight, and 70 r.p.m., the angle is accelerating 4° per 100 ft. and 3° per 100 ft. is desired, reduction of 1 to 2 tons weight on the bit with increased table speed of approximately 20 r.p.m. may produce the correct results. A drill collar, 20 ft. in length, would accomplish this with the original weight and speed, but would require a round-trip. The exact combination must be experimental, taking a sufficient number of angle shots at close intervals to insure the desired results. Once the desired angle has been attained, a 40-ft. drill collar can be used with the full-sized reamer below, and a slightly smaller stabilizing reamer above the drill collar Another variation — probably more desirable because of difficulty in keeping the stabilizing reamer clean —is to use 80 ft. of drill collars with the bottom reamer only. The greatest hazard in running too long and too stiff a combination of drill collars is the possibility of sidetracking the hole in the portion where maximum angle building occurred. If this part has been thoroughly reamed, sidetracking can be avoided by crowding the bit through without rotating until the straight-line part of the course has been reached.

If, for any reason, it is desired to drop angle rapidly, the full-size reamer is carried on top of a 30 to 40-ft drill collar, with only the bit below Application of the same amount of weight as carried in accelerating an gle will cause a drop of from 5° to 6° per 100 ft. The fulcrum in this instance is the reamer above the dril' collar, which pries the bit downward The same condition will exist if the angle is allowed to drop from excessive table speed and too little weight The fulcrum is then at the point of reverse bend, and the hole will lose angle rapidly with the application of weight. In many instances primary tools are necessary to overcome a dive or reverse bend which has been allowed to develop.

It should be emphasized that during angle building or changing of direction, sufficient number of single-shot pictures should be taken to avoid losing control of the hole. If a reverse bend or overswing is never allowed to develop, no serious loss of time nor extra expense can occur. A picture every 20 to 30 ft. will often enable the operator to make suffi-

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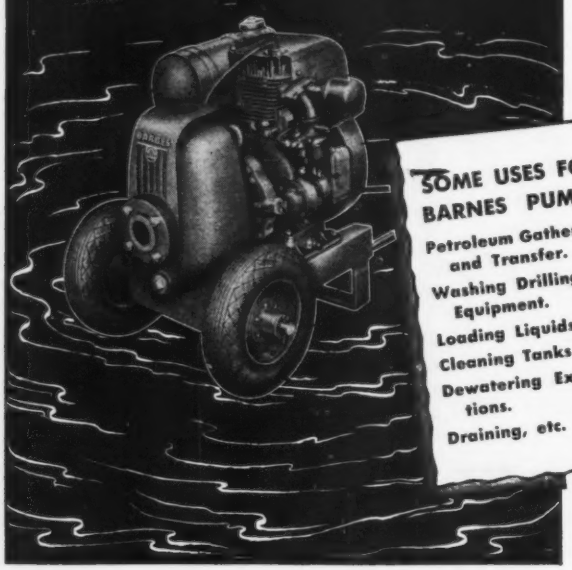

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cient changes in operating procedure, if control loss is indicated. If the combination is in use for building angle, and angle shots inside of drill pipe indicate that the angle is not appreciably changing, a directional shot should be taken at once, because a right or left swing is probably developing. Something must happen with the use of all combinations chosen to build angle. If it is not a change up or down, it must be to the right or left. Sufficient single shots taken at close intervals will enable the operator to keep or regain directional control.

Trained, intelligent drilling crews can greatly facilitate directional drilling. Drillers should be shown the proposed course and actual drilling progress so they may have a clear idea of what is to be accomplished. Experienced drillers know that the slow table speed and excessive weight on bottom are essential for results. They are thoroughly familiar with combinations of bits, reamers, and drill collars, and what can be accomplished by their use. At least the drillers and derrickmen should be able to run directional single shots and correctly read the results. The telephone then can save much lost sleep and travel time for the tool pusher and petroleum engineer.

Bits for Directional Drilling

Performance of various types of bits in the hole is one of the most controversial parts of this subject. It has been claimed that some bits pull to the left, others to the right; and, in some cases, the claims appear to be true. However, it is extremely doubtful if any type of bit will consistently, and under all conditions, pull one direction or the other. It is thought that the direction in which the bit is encountering the dipping formations and the nature of the stratigraphy play by far the more important part.

Many of the early directional holes were drilled with a three-way disk bit. Its drawback was the inability to survey through it as is done with wire-line coring bits. However, the development of nonmagnetic drill collars, now available, would eliminate this objection. Slant-hole drilling is done with either three or four-bladed drag bits or rock bits, which may be cross-section or cone-type. Directional work is easier when drilling with drag bits, but this is probably because the softer formations which permit drag-bit drilling facilitate drift. Although the wire-line-type bits permit open-hole single shots without coming out of the hole, these bits do not make the amount of footage possible with the conventional type. For this reason the nonmagnetic drill collar has a decided advantage in allowing more footage per bit as well as permitting directional single shots without retrieving a center bit. These collars are 23 ft. long with steel subs for the top and bottom. They rent for $50 per day, but an outright purchase at about $3,500 would be justified if a continuous program of directional work was planned. Single shots in these drill collars usually show about ½° less angle than open-hole shots, whereas pictures taken through a center bit hole may be from ¾° to 1° less angle than is shown from an open-hole picture.

Recently there have been developed special directional drilling bits called "trigger bits," through which a survey barrel can be run and allowed to protrude below the bit sufficiently to permit a directional picture.

Variations also occur in the results obtained from using the differential bit as a hole opener. In the Rincon field this bit followed the rathole by the whipstock perfectly, whereas in the Jacalitos Canyon field the same bit consistently sidetracked the rathole and was discontinued in favor of the conventional hole opener. Full-size primary tools will eliminate sidetracking of the rathole.

It is felt that the most satisfactory method of altering the course of a hole to right or left is to use either a whipstock or knuckle joint. The latter has done some excellent work

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with far less mechanical hazard in a high angle hole. For maximum turn with a knuckle joint, the hole can be underreamed locally, as amount of turn depends on the size of the hole in which the knuckle joint is used.

Precautions

In planning the hole size for a directional well, a little additional clearance should be allowed. If the hole is thoroughly reamed, 8⅝-in. collared casing will follow a 12¼-in. hole, accelerated as much as 5° per 100 ft., to a drilled depth of at least 3,500 to 4,000 ft. Similarly, 7-in. collared casing will follow a 10⅝-in. hole; 5⅞-in. drill pipe is commonly used in hole sizes from 12¼ to 15 in. in diameter but does not allow angle building much in excess of 3° to 4° per 100 ft. The most common size of drill pipe for directional work is 4½ in., which lends itself readily to all combinations of hole sizes from 9 to 12¼ in. Extreme caution must be used in drilling directionally with 3½-in. drill pipe, inasmuch as it is possible to flex this or a smaller size beyond the angle that can be followed by casing. Less weight carried on bottom, a little higher speed of rotation, and sufficient number of angle shots will avoid loss of control when using 3½-in. drill pipe.

In developing a right or left turn in a well bore, care must be taken to avoid an overswing. If the use of a 40-ft. or longer drill collar does not overcome this tendency, a rathole drilled for 20 or 30 ft. followed by a hole opener may be successful. Care must be taken in this operation not to crowd the bit, but to let it start to dig with minimum weight and relatively high speed of rotation. If the swing comes around to the exact desired course and more angle is needed, a whipstock set for angle only and no change in direction will stop this swing.

In high-angle drilling, there are always excessive risks of a fishing job, the chief causes being key seating, improper handling of mud, insufficient reaming, and carelessness. The bore must be properly mudded to avoid any sloughing, and the sand content of the mud kept at an absolute minimum. Key seating can result from too rapid angle building, as well as insufficient drilling progress where the drill pipe rotates with very little change in position. One exceptionally bad fishing job resulted when, with a high sand content in the mud, the driller pulled the bit only 5 ft. off bottom and, without rotating the pipe, allowed the crew to grease up. Another resulted from making a minor clutch repair on the rotary after pulling just 11 ft. off bottom. Each of these very costly jobs (necessitating redrill of most of the hole in one case, and a long washover job in the other) could have been

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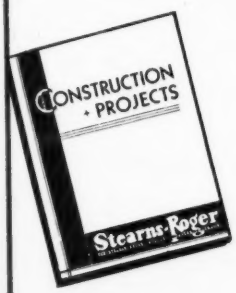

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avoided by a little care and foresight. It is recommended always to come out of the hole for any repairs. When greasing up, the bit should be pulled well off bottom and kept rotating, except when greasing the rotary drive itself. Mud circulation should be maintained.

Although considerable torque builds up during the drilling of high-angle holes, it is rarely sufficient to cause failure in modern drill pipe without other contributing causes. One company reported a 30-per-cent reduction in torque in a 60°-angle hole when using 4½-in. instead of 5⅝-in. drill pipe. It was also reported that the amount of torque developed in one hole with a 60°-angle from 1,800 to 5,500-ft. drilled depth indicated that grade "E" drill pipe should be used for deeper drilling.

In the drilling of wells with extremely high angle, it is recommended that a protection string of casing be set after all angle has been built, and the course straightened out in line with the final objective. In this manner most fishing jobs will be avoided. However, if they do occur, the expensive portion of the hole is saved.

It is extremely hazardous to run flush-joint casing in a slant hole. The collars are essential to break up the mud sheath on the wall, and a long string of flush-joint casing acts the same as a flat pane of glass dropped in the mud. Surface tension may freeze the casing. Long flush-joint liners have been run successfully at Huntington Beach, where drilling into the oil zone was done with oil as the circulating medium.

There is particular difficulty in forcing cement completely around the casing in a slant hole, inasmuch as the pipe lies on the low side and the circulation flows more readily along the high side of the casing. In cementing, several spring equalizers are desirable—usually three or four on the shoe joint, with two or three on each of the next two joints above. The use of several wire scratchers on the bottom two joints is recommended, even though they become mashed down while the casing is being run.

If the oil zone has been penetrated prior to running the water string, it is desirable to test for water shutoff by shooting holes 5 to 10 ft. above the shoe. A running cement bridge placed below the shoe has in some instances caused the sidetracking of the hole below . . . .

It is believed that lost hole can be recovered in almost every instance if the exact point of takeoff is known, and good survey records have been kept on the original hole. Such loss invariably will occur at a bad dog leg, with the new hole taking off along its previous course. It is necessary, therefore, to plug the new hole solid with cement to avoid the future danger of entering the new hole while running casing. By coming to the exact point of loss, the operator is dealing with two dimensions. At any other point three dimensions are involved, and an error of 1 ft. may result in missing the hole altogether. If the second whipstock setting is the same as the first, the bit must go into the old hole. However, before a new hole should be allowed to develop, a pilot bit, preferably a "side-hill" type, should be tried first.

Accomplishments

Operators in different producing areas in the United States have varying concepts of high-angle holes. The average slant hole in the Rocky Mountain states is about 6°. In the Gulf Coastal fields the average angle of deflection is 14° to 15°; whereas on the Pacific Coast 30° is the average, and 60°-angle holes are relatively common.

Some rather remarkable results have been recorded which show the possibilities of slant-hole drilling. One well in the Argentine had an acceleration of 5° per 100 ft. from the surface, attaining an angle of 45° at 900 ft. A well drilled under tidelands in the Rincon field was drilled vertically for 165 ft., and reached an angle of 56° from vertical at a drilled depth of 1,230 ft. Total horizontal drift of this well was approximately 3,150 ft.

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in attaining a vertical depth slightly less than 2,800 ft. Another record hole was drilled at Seal Beach to about 7,000 ft. where an angle in excess of 80° from vertical was developed with a horizontal drift of approximately 5,500 ft.

Several tideland wells at Huntington Beach have exceeded 60° from vertical at drilled depths ranging from 4,000 to 4,500 ft. Horizontal drift was approximately 3,000 ft., and close control was maintained. One such well was confined to a 50-ft.-radius cylinder from the surface to bottom, yet was drilled to within 20 ft. of its objective with only five primary tools.

About 6 years ago in the Long Beach Harbor area, directional wells drilled to depths of 3,200 to 3,300 ft. took from 24 to 28 drilling days. Today, with trained crews and improved tools and methods, similar holes require from 9 to 14 days to complete.

Slant-hole drilling might be carried much further by the development of a ramp or sloping platform, adjustable to a desired angle, in place of the usual derrick or mast. Thus, the hole actually could be aimed toward the objective from the surface. Drilling could be done by a hydraulically driven rotary table, with the pipe snubbed in and out of the hole. This same hydraulic drive could snub the casing into the hole, greatly reducing the hazard of sticking the pipe. These wells could be pumped hydraulically, with bailing as the chief mechanical problem.

At present it is inadvisable to drill directionally at depths in excess of 9,000 ft. It is possible, but costly and hazardous. It is equally undesirable to whipstock wells in steeply dipping, alternating hard and soft formations, or in hard formations which cannot be drilled at a rate in excess of 2 ft. per hour. In rugged topography with fairly easy drilling in sands and shales—such as the 4,500-ft. wells in the Jacalitos field—a directional well will cost about $4,500 to $5,000 more than a vertical hole. If, then, a vertical location is possible by an expenditure of an amount under $5,000, the vertical well is always recommended.

Special thanks are extended to M. A. Machris, vice president of Wilshire Oil Co., Inc., for permission to publish the data; to F. W. Lake, assistant manager, producing department, Wilshire Oil Co., Inc.; to Gordon Jackson, vice president, Eastman Oil Well Survey; and to members of the California drilling-practice committee of the American Petroleum Institute.

References

1. Gordon Jackson, "Improved Techniques and Methods in Controlled Directional Drilling," Petroleum Engineer 17 (8) 84-90 (1946).

2. D. K. Weaver, "Pumping Slant Holes at Huntington Beach, California," Drilling and Production Practice, 138-47 (1937).

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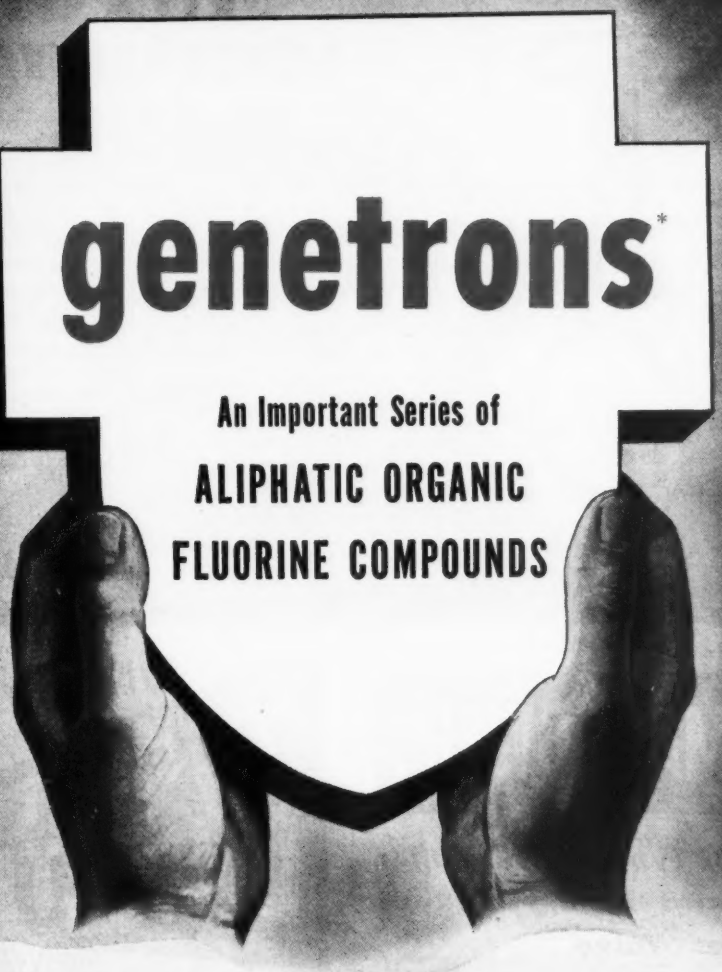

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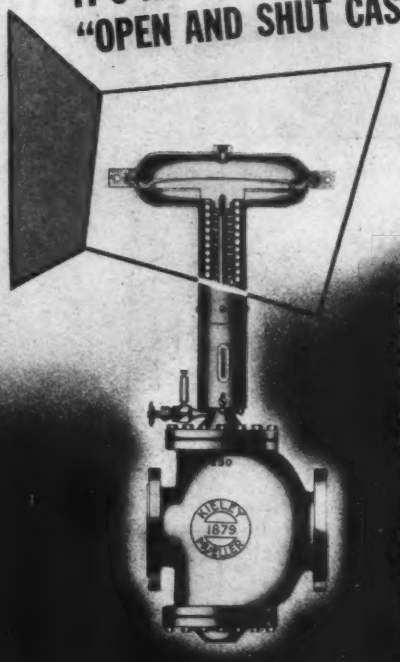

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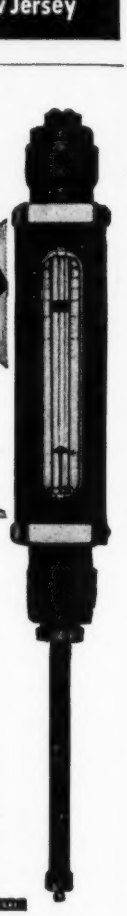

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A.P.I. Symposium:—

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For several years the American Petroleum Institute through its members and committees has devoted much attention and effort to "Secondary Recovery of Oil"—and those important methods that secure additional crude after the "flush" days of oil pools are gone. In continuing the studies at the annual meeting in Chicago this week, a symposium on secondary recovery was held. Given here are all of the papers, in abridged form, presented at that symposium.

Separators and Tanks

by W. L. McCloy, Jr.

Consideration is given to methods and equipment used in the delivery of oil from the well as "well fluid" through the various stages of separation to the stock tanks as "pipe-line oil." Various methods and equipment "hookups" for treating emulsions are set forth diagrammatically. The author is with The Standard Oil Co. (Ohio), Cleveland.

A. Gas-oil separation. — Separators are manufactured in pressure ranges from 125 to 3,000 psi., and for even higher pressures for special purposes. When gas is to be returned to the reservoir, stage separation may be advantageous if high pressures are involved.

For safety reasons, every new high-pressure separator should be equipped with a relief valve set to "pop" at the "designed working pressure," and a safety head designed to rupture at 150 per cent of said working pressure.

It is interesting to note the effect of separator pressure on the gravity of the oil produced. In one known example, the A.P.I. gravity of stock-tank oil was increased by 2° by increasing the separator pressure from 18 to 45 psi. Inasmuch as oil increases in volume approximately 2½ per cent per degree increase in A.P.I. gravity, the effect was to increase the volume of stock-tank oil by 5 per cent for a given amount of fluid withdrawn from the reservoir.

B. Oil-water emulsion separation.— Principal methods of handling emulsions involve treatment with:

1. Heat.
2. Gravity methods.
3. Chemicals.
4. Electricity.
5. Combination of the foregoing.

Heat treatment of well fluids is applied in a number of ways involving:

1. Fire applied to stock-tank bottoms.
2. Steam coils in stock tanks.
3. Separate external heaters, through which the well fluid is passed.
4. Patented flow treaters.

Gravity methods of separation involve the difference in specific gravity of oil and water. When emulsions form, combinations of gravity methods, heat, chemicals, and mechanical circulation are often the solution of the problem. In order to apply all of these treating methods, a tank battery would usually include a heater, a free-water knockout, a flume or boot, a settling tank, and a siphon. All of these devices may be combined in a flow treater, or may be added piece by piece when needed.

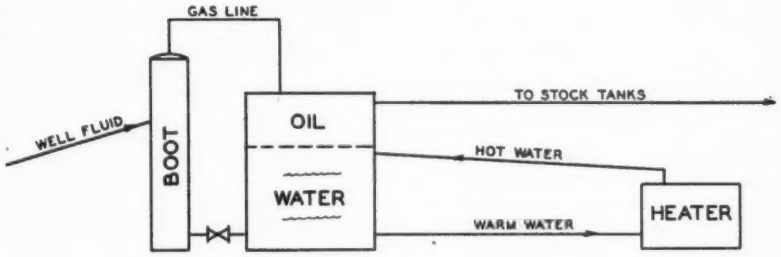

Fig. 2—Thermosiphon system

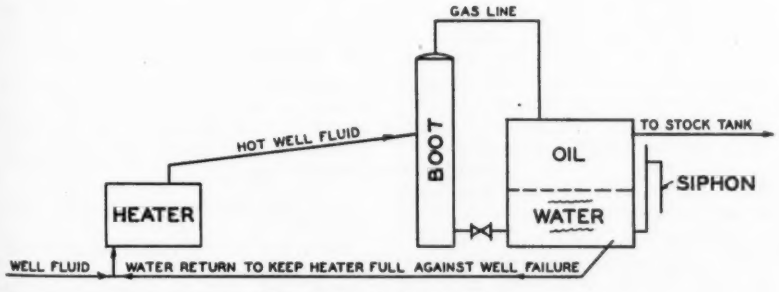

Fig. 1—Flow-line-type system

Treater systems may be generally divided into three types other than the flow treater mentioned hereinafter. These three types are:

1. Flow-line system.
2. Thermosiphon system.
3. Flow-line-thermosiphon system.

The flow-line system is shown diagrammatically in Fig. 1. All the fluid from the well passes through the heater, and is heated to temperatures as high as 180° to 200° F. From the

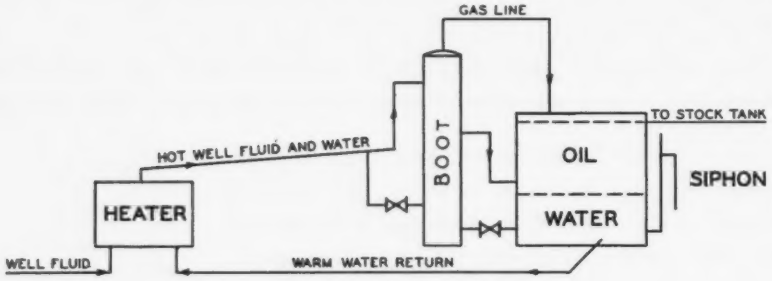

Fig. 3—Thermosiphon system

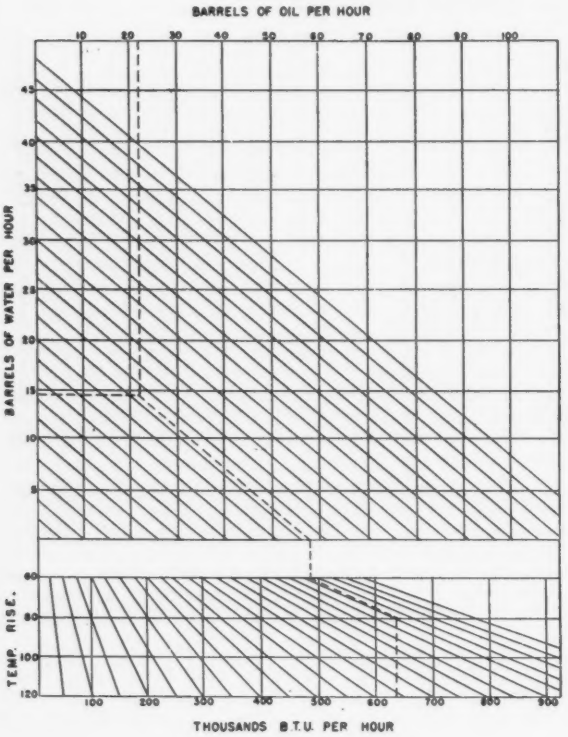

Fig. 4—Selection of heaters

heater the fluid goes into a "boot" alongside the settling tank, or goes into a flume inside the settling tank. If there is a great excess of free water, it may be necessary first to pass the fluid through a water-knockout tank ahead of the heater, and allow only oil and emulsions to pass through the heater.

The thermosiphon system shown in Fig. 2 requires essentially the same equipment as the flow-line type, but arranged differently. It is connected in such a way that only water goes through the heater. Well fluid goes directly from the well into the "boot" or flume of the settling tank, and out into the bottom of the settling tank into hot water. The well fluid is thus heated in the settling tank by hot water. The oil emulsion rises to the top, and the oil is cleansed of its suspended water particles. Although a higher heater temperature may be required, it can be more safely applied to water.

A combination of the foregoing two systems might be called the flow-line thermosiphon system as shown in Fig. 3. It is said to have a better heat balance than either of the two, as a part of the hot water from the settling tank circulates back through the heater where it mixes with well fluid, and both are forced into the boot or flume and on into the settling tank. It might be noted that somewhat lower temperatures are effective at the heater in this system.

Flow treaters, which have been manufactured in recent years, have been found very effective as a combination of the features of a separator, water knockout, settling tank, and heater all in one unit. This type is available from several manufacturers in various sizes to operate at pressures from atmosphere to 25 psi. It includes a built-in fire tube, free-water knockout, settling area, and oil zone, and can be readily installed or moved as a unit, and is completely salvable. It has been found wanting, however, in areas where the crude is extremely corrosive, due to the high cost of repairs. Where very large quantities of water are produced, it is often necessary to augment the flow treater with a water knockout. If gas volumes are extremely high, a separator may likewise be needed.

When gas volumes are not too large, the flow treater will serve as a gas separator.

Fig. 4 can be used as a guide in the selection of heaters on a B.t.u.-requirement basis, and should be helpful as a reference. It can be used in the selection of a flow treater or any other type of heater, if the B.t.u. factor of the heater is known.

Chemical methods are usually necessary to break down tight or stable emulsions that cannot be handled by simple mechanical procedures together with heat. In many cases a combination of the three is practiced. Treating chemicals are available from several manufacturers; most of them are wetting agents or soapy substances. Most patented treating chemicals are cataloged by number, and applied to treating problems on a "cut-and-try" basis after preliminary laboratory tests on well fluids.

Storage

After oil has been produced from the well and separated from salt water and emulsions, it might be presumed to be ready to sell to the pipe line. However, it still has to be measured and sold "by the barrel." The buyer must also examine what he buys, and this examination involves measurements of temperature, gravity, and freedom from water and sediment. Oil is measured, stored, and examined by the buyer in the stock tanks.

Tentative A.P.I. specifications are published for wooden tanks.* Approved A.P.I. specifications for bolted steel tanks are available,† and tentative A.P.I. specifications are published on all-welded production‡ tanks.

Methods of Measurement

When accurate measurement of individual well production is necessary, operators resort to several methods such as:

1. Individual well-test tanks varying in size from a 50-gal. oil drum for short tests to 15 to 65-bbl. receivers. Well fluid may flow, or be pumped directly into such tanks and measured.

2. Portable test tanks that can be moved from well to well.

3. Header and lead-line connections that permit passage of well fluid directly into an empty stock tank at the battery, by passing the treater.

4. Gas-oil ratios, of course, must at times be determined, and test separators may be needed unless the well fluid can be isolated by flow lines, headers, etc.

*A.P.I. Std. 12-E: Wooden Tanks, 2nd edn., Sept. 1944.

†A.P.I. Std. 12-B: Standard Bolted Tanks, 2nd edn., Sept. 1944.

‡A.P.I. Std. 12-D: All-Welded Production Tanks, 3rd edn., Sept. 1944.

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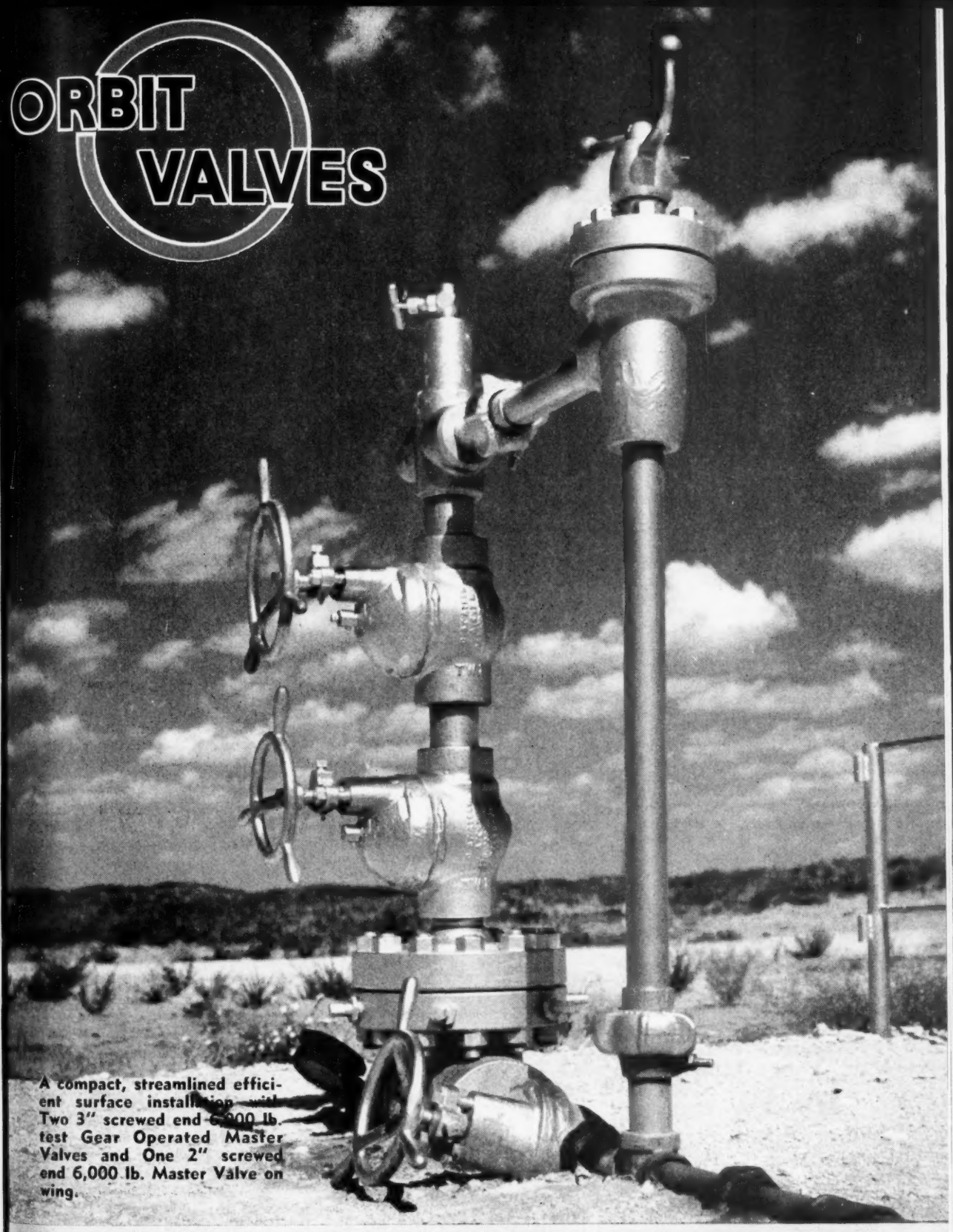

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Flowing Water-Flood Production

by T. F. Lawry

Advantages of flowing over pumping lie in the simplicity of operation, and economy of first cost, as well as of operation. Flowing is used mainly in the shallow water-flood operations in the Mid-Continent sands, in which permeability and viscosity do not seriously retard the injection of sufficient water volume. Experience to date indicates no difference in the ultimate recovery of water flooding—whether by flowing or by pumping.

The author is associated with The Ohio Oil Co., Eureka, Kans.

PRACTICALLY all of the fields in which water-flood oil wells are produced by flowing are located in the Mid-Continent region, which comprises eastern Kansas, northeastern Oklahoma, and north Texas. There are several reasons why flowing is largely restricted to this area:

1. Most of the pay sands are of shallow depth.

2. The sands have, for the most part, good permeability to water.

3. The sands being water-flooded are not so prolific that any economies which may be effected can be overlooked.

The history of flowing water-flood production in the Mid-Continent is similar to that of almost all techniques in the petroleum industry. It began as an experiment at a time when the lease on which it was tried had declined in oil production and gained in water production, until the latter was almost predominant. Fig. 1, although chronologically not an early flowing flood, is typical of the case history of many water floods which were converted from pumping to flowing after the economic life by pumping had been reached. The first reaction to the decline suffered upon conversion to flowing was one of doubt: flowing was apparently getting only one-half of the oil that could be obtained by pumping. On the other hand, if it was costing more to produce the oil than the oil itself was worth in the stock tanks, the only alternative to flowing was to abandon the lease. This feeling of "having nothing to lose" paved the way for a more common practice of pumping the wells until economic life by pumping had been reached, and then to convert the oil wells to flowing. This was still an expensive procedure, because pumping equipment large enough to handle the peak oil production on the lease had to be installed, and then, later, there was an additional expense in making the change from pumping to flowing. The operator who was not yet ready to accept flowing on equal terms with pumping felt that this was the most certain method by which he could get out all of the obtainable oil. At present the greatest confirmation of the success of flowing in water flooding lies in the increasing tendency of more and more operators to develop their properties, having in mind no other producing method than flowing.

Advantages of Flowing

The more evident advantages of flowing over pumping water-flood production are well known, and have been mentioned in every speech and paper that has been given on the subject. In quick review, they are: (1) The capital cost per oil well drilled and completed is less, due to absence of pumping equipment. (2) The oil well produced by flowing virtually operates itself, due to absence of mechanical parts. (3) Labor requirements in flowing are much smaller, as well-servicing crews, mechanics, power and rod-line gangs, etc., are not necessary.

Permeability and Crude Viscosity Influence Flowing

In shallow pools where the crude is of high viscosity, occurring in sand of low specific permeability, there is considerable doubt in the writer's mind that flowing is much more economical than pumping. Because of the shallow depth, the maximum pressure that the formations will stand without break-through is limited. If the viscosity of the crude oil is high, and the permeability of the sand low, every unit of energy available will be needed for lateral movement of oil in the formation, and any energy required for vertical movement in the bore of the producing well will simply be an unfortunate drain on the energy system.

It is not within the scope of this paper to state the limits of permeability or crude-oil viscosity which would provide a line of demarcation between water-flood operations which should be pumped and those which may be flowed. In the first place, sufficient data have not been collected by anyone to permit establishment of limits due to the influence of either permeability or viscosity. In the second place, permeability, viscosity, depth, and spacing all enter into the question of economy of flowing over pumping. At a depth of 1,000 ft., low permeability is a much less troublesome characteristic than it is at a, say, 500-ft. depth, because greater injection pressure can be used at the former depth to overcome the limitation imposed by low permeability. The same holds true for high crude-oil viscosity at greater depth. On the other hand, at a 1,000-ft. depth the close spacing usually employed at a 500-ft. depth would involve considerably greater development cost

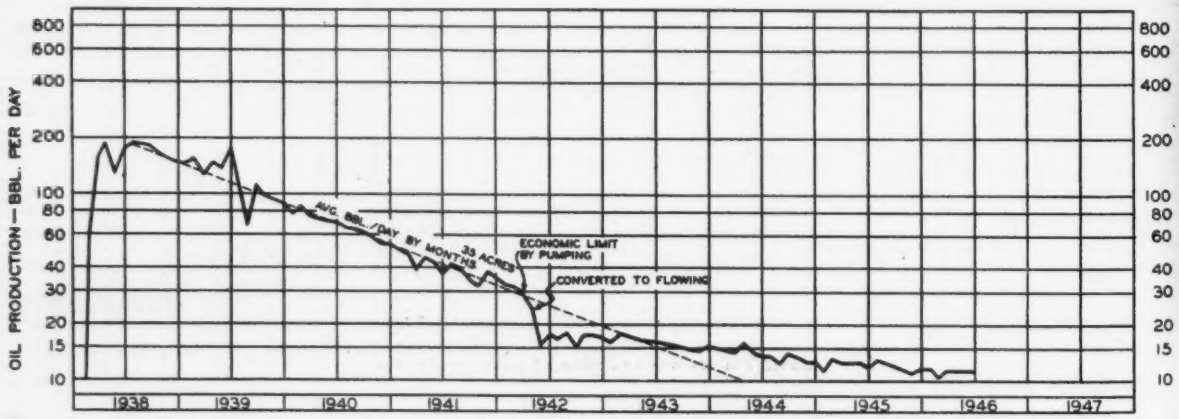

Fig. 1—Typical water-flood decline curve, showing long depletion period possible by flooding

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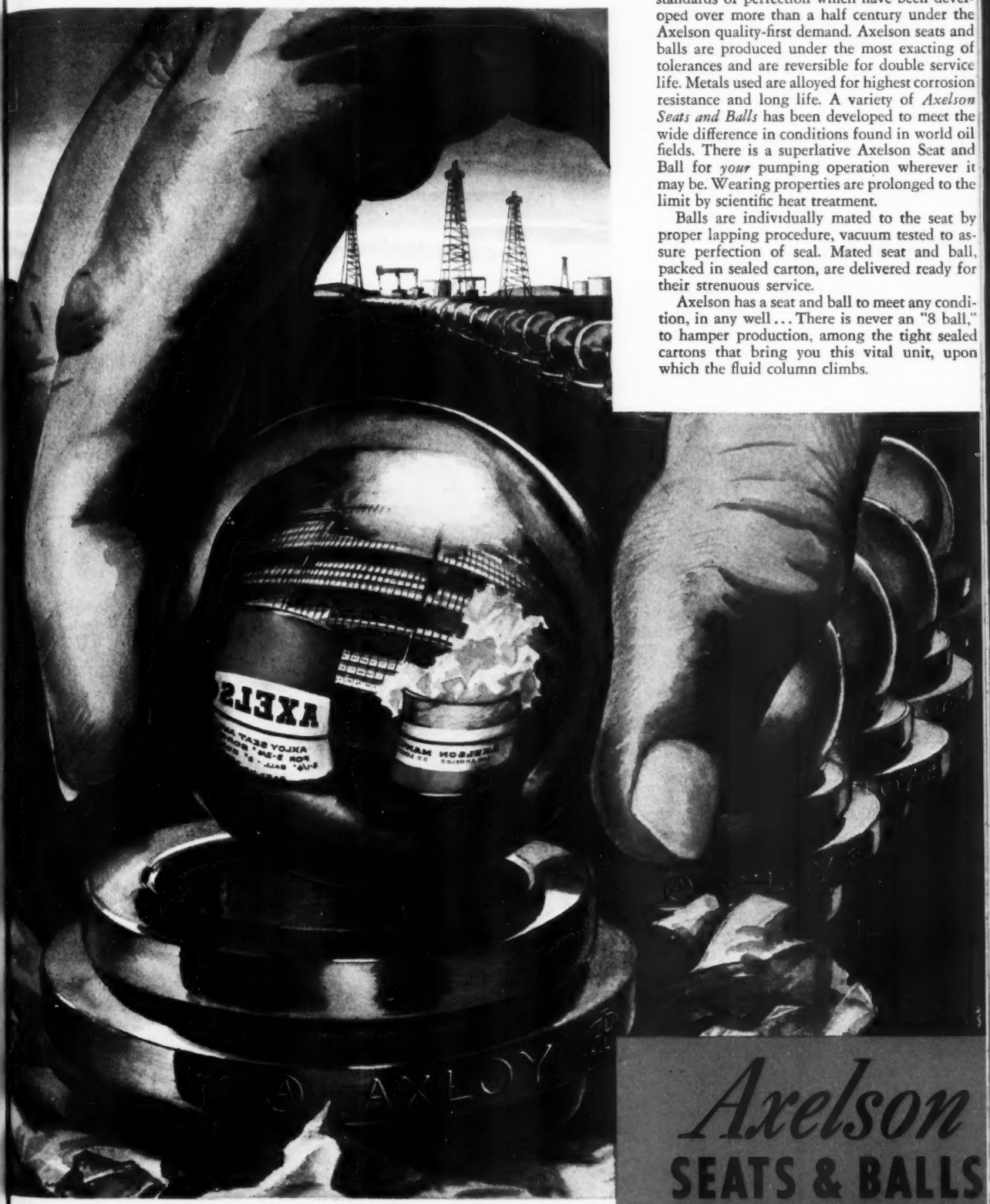

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James A. Gray, of Houston, Texas, is the purchaser of our stock. He is well known by most of you and has been a close personal friend of both of us for years. We know that we are putting our company in good and competent hands. Mr. Gray has assured us that there will be no changes in policy or personnel. This is being borne out by his selection of new officials for the Company.

Mr. Gray, of course, will be president. Mr. M. G. McCool, who has been our Secretary and Sales Manager, will be Vice-President in charge of Sales and Manufacturing. Mr. V. L. Thomas, who has been our Controller and Assistant Secretary, will be Secretary and Treasurer. Other than this there are no contemplated changes.

We want to thank you for the fine, friendly consideration you have always extended us and sincerely hope that you will continue to cooperate in the same manner with the new owners.

Sincerely,

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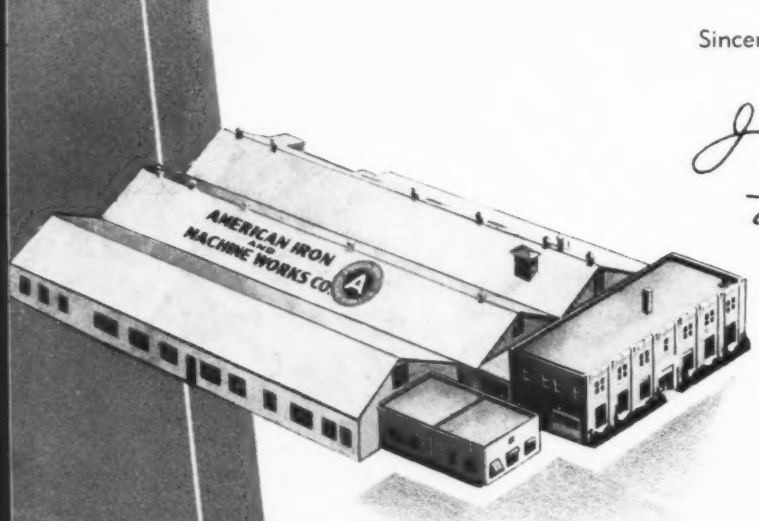

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per acre; therefore, wider spacing would be a choice. At wider spacing, some of the advantage of depth as mentioned previously, will be lost with the smaller number of injection wells employed at greater depth. Therefore, a much more satisfactory procedure for an operator to follow, in attempting to fit his new water-flood project into the picture of pumping vs. flowing, is to depend upon an engineering report by someone with a fund of experience rather than to attempt to consult a permeability-viscosity table to answer the question of whether his water-flood production should be pumped or flowed.

Some water floods in eastern Kansas are being flowed successfully at depths of 500 ft. and greater, in which the crude-oil viscosity is 25 centipoises at reservoir temperature and permeability is as low as 30 millidarcys (by air). There may be other floods being flowed with success in which permeability is lower or viscosity higher, or at lesser depth, but the data are not available to the writer at this time. The foregoing sand and crude characteristics seem to be the limit at the present writing. The tendency is toward flowing in tighter sand containing oil more difficult to move, but that trend is recommended for those operators who have considerable experience with flowing and who realize the further limitations imposed by lower permeability and higher viscosity.

Pumping-Equipment Selection for Secondary-Recovery Developments

by E. N. Kemler

Summary data are given on horsepower requirements available on small and shallow wells. Proper counterbalancing is a most important factor to be considered, both on central powers and beam wells. The author is associated with Southern Research Institute, Birmingham.

IN the selection of equipment for the pumping of wells, consideration must be given to the power requirements, the peak-load requirements, and the peak-torque requirements. The power requirement determines in part the size and characteristics of the prime mover. The peak-load requirement fixes the size of the structural members, and the size of the rods needed. The peak torque required by the cycle determines the size of the transmission needed, including the clutch, belts, gears, or chains, and the shaft sizes. In the application of stock sizes of pumping equipment, the engineer must be certain that the equipment can handle the peak loads and torques. Although these peak values are dependent on the pumping cycle, the rod sizes, and the pump size, they can also be influenced by the design of the installation, and by the care used in the counterbalancing of the system. By proper counterbalancing, the size of installation required can be considerably reduced. Likewise, by failure to maintain a pumping system in proper counterbalance, the equipment can become greatly overloaded. The operator of equipment can influence the peak torque on equipment by a factor of 2 to 1, depending on the amount of counterbalance used and the care used in properly counterbalancing. . . .

Power Requirements

Fig. 1 lists data taken in five wells covering a wide range of pumping cycles.[1] These data cover the general range of conditions that might be expected in wells between 1,000 and 1,500 ft. For shallower wells there are few data available, so that any prediction of horsepower requirements must be an estimate. Fig. 2 shows representative data on 2,500-ft. wells as shown by three series of tests. These data show that horsepower requirements tend to increase more rapidly than in direct proportion to pumping speed.

In central-power installations rod-line losses constitute a very important factor in determining the entire power requirements. Power loss in rod lines is difficult to evaluate, as it varies with rod size, speeds, type, and spacing of carriers, profile of the line, and other physical factors. Fig. 3 gives some representative data for ⅞-in. rod line.[1] This program gives rod-line loss per 1,000 ft. of line for representative pumping speeds or rod-line travel. For moderate pumping cycles the loss is about 1 hp. per 1,000 ft. of line.

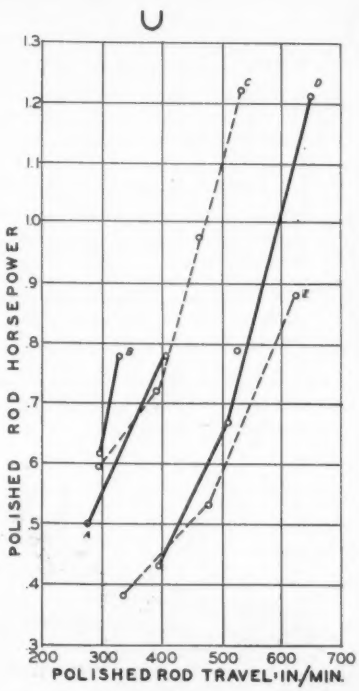

Fig. 1 — Polished-rod horsepower 1,300 to 1,500-ft. wells. Diameter of plunger is 1¾ in.

The total power requirements of a central-power installation must include the sum of polished-rod horsepower and rod-line horsepower. When there is an excessive number of swings, dummies, holdups or holddowns, some allowance must be made for them. Friction losses in rod lines or pumping wells can result in much higher horsepower requirements than indicated.

Polished-rod loads may vary as

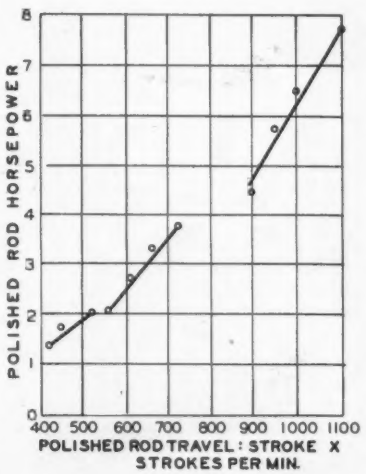

Fig. 2 — Polished-rod horsepower 2,500-ft. wells; 1¾-in. plunger

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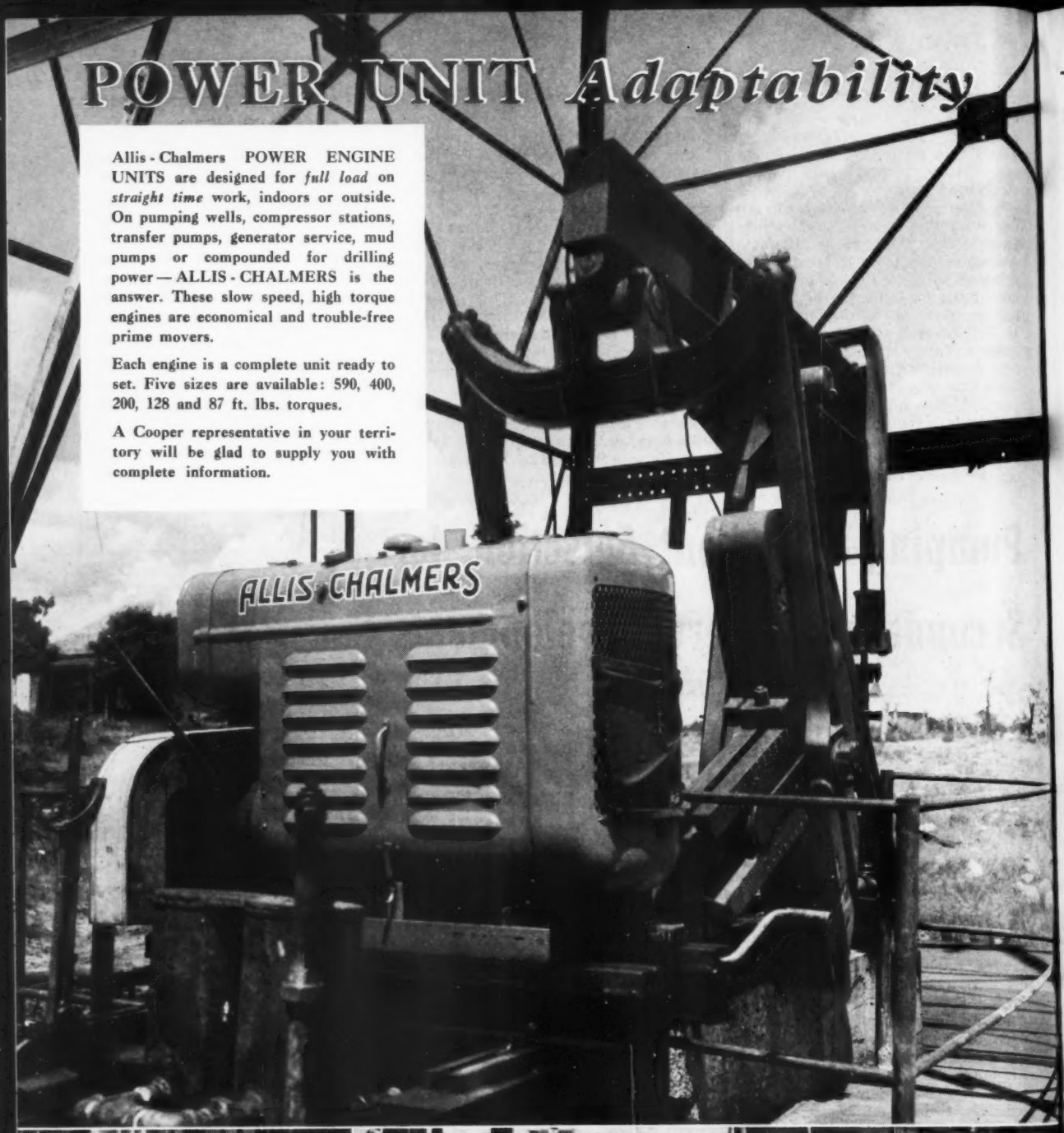

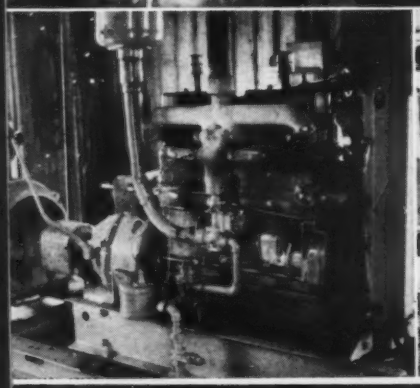

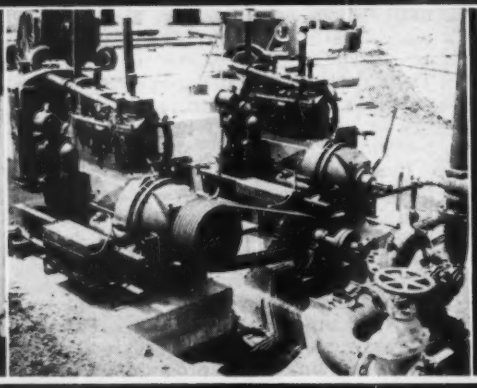

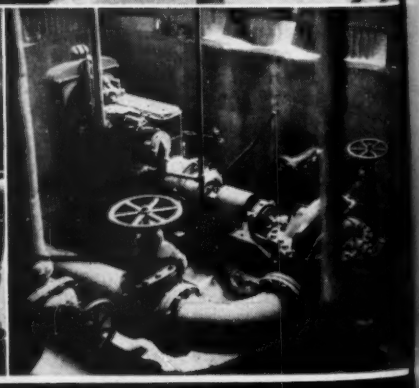

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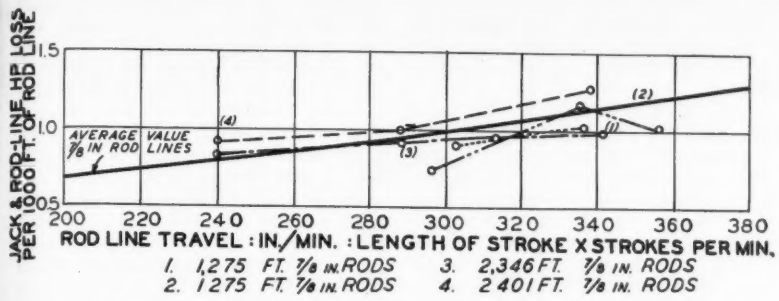
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(2)
(3)
(1)
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2. 1275 FT. 7/8 IN. RODS
3. 2,346 FT. 7/8 IN. RODS
4. 2401 FT. 7/8 IN. RODS

Fig. 3—Jack and rod-line horsepower vs. rod-line travel, in inches per minute

much as polished-rod horsepower. Friction of the rods and plunger probably account for the greatest part of this variation. Unless dynamometer data are available, the best estimate of peak load can be obtained for the Slonneger formula:

$$\text{Load} = (W_r + W_o)\left(1 + \frac{NL}{5{,}400}\right)l$$

where:

W_r = weight of rods per foot.

W_o = weight of oil column on plunger per foot.

N = strokes per minute.

L = length of stroke in inches.

l = depth of well.

For a 1⅝-in. rod string and 1¾-in. plunger, $W_r + W_o$ is approximately equal to 2.2 lb. per foot. Fig. 4 gives the quantity $1 + \frac{NL}{5{,}400}$ for various products of NL.

Balancing

Balancing of wells is most easily accomplished in the field.[2,4,5] Many discussions of methods of counterbalancing are to be found in the literature. The simplest and easiest applied method is that of slipping the clutch.

Counterbalancing of central powers is equally as important as that of individual wells. The effect on the prime mover and on the central power itself is as destructive as on an individual unit. However, the counterbalancing of such wells is somewhat more difficult; and, inasmuch as counterbalance cannot be used on individual wells and still maintain good rod-line operation, the use of dummies is necessary. To calculate the position and amount of dummies is somewhat more difficult, and requires calculations based on well loads and positions. Several methods have been proposed in the literature which are entirely satisfactory for work of this type.[3] . . .

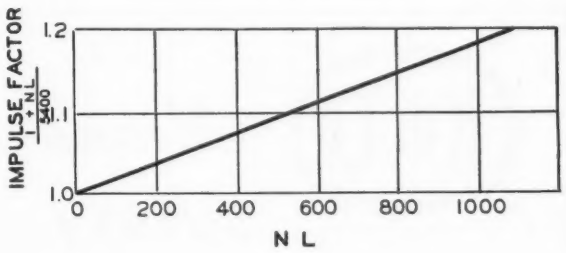

Fig. 4—Relation of impulse factor to product of stroke length times strokes per minute

References

1. Eugene Hosford and Emory N. Kemler, "Typical Dynamometer Cards and Their Application," Drilling and Production Practice, A.P.I., 81 (1939).

2. Emory N. Kemler, "Counterbalancing of Oil-Well Pumping Machines," Drilling and Production Practice, A.P.I., 87 (1943).

3. Emory N. Kemler, "Counterbalancing of Control Powers," Oil Weekly, 108 (13) 31 (1943).

4. Emory N. Kemler, "Proper Counterbalance—An Equipment Conservation Measure," Oil Weekly, 108 (6) 9 (1943).

5. Emory N. Kemler, op. cit., 103-4, discussion by D. O. Barrett.

Use of Plugging Agents

by Harvey T. Kennedy

Plugging agents in secondary-recovery operations include various finely powdered solids—such as cement, colloidal clays, and wax distillate — added to the water in flooding. Smokes of various compositions as applied to repressuring projects are discussed. The plugging of water, which bypasses oil in fields which are not being artificially flooded or repressured, conserves propulsive energy, and allows commercial production of oil that could not otherwise be obtained. It may, therefore, be considered as a method of secondary recovery itself.

The author is associated with Gulf Research & Development Co., Pittsburgh.

SINCE my last report[1] on this subject there has been continuous improvement in plugging materials and in methods of applying them. Plugging agents serve two main purposes in secondary-recovery projects. They are added to the injection fluid in water flooding and repressuring projects to form selective plugs on and in the sand surrounding the input well. In "watered-out" fields they are injected into the water-bearing portions of permeable formations. Although the function of both treatments is broadly the same, the materials and methods used differ to such an extent that separate discussion of the two treatments is warranted. . . .

Appreciation of the losses incurred in bypassing and the benefits resulting from control of bypassing have stimulated a great deal of investigation in recent years. A number of patents[2] describing methods of plugging loose strata, without at the same time appreciably affecting the flow into tighter streaks, have been issued. Laboratory tests on a number of materials have indicated that a high degree of selectivity is obtainable, and field tests have shown that under proper conditions this selectivity may be attained in practice. The various types of materials and the methods of using them will be described in detail.

Plugging with Solid Particles

One of the first plugging materials employed in the Bradford area was portland cement in very dilute suspension. In this application the hydrating properties are apparently of minor importance, but the distribution of particle sizes is such that a sand of 2,550 md. permeability is plugged to the extent of 40 per cent

whereas a sand of 128 md. was unaffected. The selective action is aided by the fact that the looser sand takes more of the suspension and, thus, more of the plugging particles, starting with some 20 times the amount taken by the tight sand.

It was found, however, that the plugging effect was due largely to a filter cake on the well wall, which was easily removed and which could not be expected to be permanent in an injection well. By removing the larger cement particles by elutriation, a suspension was obtained which reduced higher permeabilities by plugging pores inside the sand, and which was removed to a lesser extent by backflow. However, the magnitude of the permanent reduction was only 8 per cent of the original permeability.

Colloidal clays such as bentonite have been tried in water-flooding experiments, as well as talc, whiting, zinc oxide, and calcium silicate in gas drives, with results similar to those obtainable with unprocessed portland cement. Only on cores with permeabilities considerably greater than those found in producing formations could appreciable plugging be obtained.

Experience with various plugging materials in northern Pennsylvania has indicated that, for the sands encountered, the materials with very small particle sizes are superior. It is natural, therefore, that colloidal dispersions should be tried, and that results with them should be more promising than parallel results obtained with coarser materials.

In laboratory tests colloidal dispersions of wax, properly stabilized with dispersing agents, have been found particularly effective. It is probable that the softness of the wax particles allows them to be distorted in the sand pores, improving their sealing action. Yuster and Calhoun[3] report results on 2 properties involving 33 wells, in which 17 and 10 gal. of wax per well, respectively, were employed. Both properties showed selective action in that their water-oil ratios were appreciably decreased. One property showed a substantial increase in oil production which resulted from an increase in input-water pressure, which in turn was made possible by the decline in water demand by the plugged wells.

K. H. Andresen[4] conducted experiments involving 26 wells in 2 blocks. H found that large immediate reductions in intake capacity were caused by the addition of 3 to 15 gal. of various types of wax emulsions to the injection water, but that continued flow caused the intake capacity of the wells to increase until a steady intermediate value was obtained. Further additions had the same effect: each staple value of water-intake capacity was lower than the previous one. Slight selective action was observed in both test areas: water-oil ratios were reduced in one area from 22.2 to 18.3, and in the other from 38.0 to 37.6.

In a report soon to be published,[5] the selective plugging properties of smokes from various sources in gas and air-injection programs are described. Vaporized rosin, stearic acid, paraffin, and ammonium chloride were mixed with air, and the mixture containing very fine condensed particles was passed through sand cores with permeabilities varying from 8 md. to 675 md. In all cases greater percentage reduction was observed in the cores of high permeability. Rosin smoke showed no effect on a core of 90-md. permeability, but reduced the permeability of a 675-md. core by 84 per cent. With smoke from paraffin, the tighter core was affected to the extent of 50 per cent whereas the looser showed a reduction of 98.4 per cent. Field tests with paraffin smoke gave inconclusive results. . . .

Plugging Water Sands in Producing Wells

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prising secondary recovery. This is probably because early efforts to stimulate production were applied to fields like Bradford, which have no natural water drive, and the term "secondary recovery" has been accepted as describing fluid injection into reservoirs as practiced in these fields. To accomplish the same purpose in the East Texas field, however, requires plugging of water sands in producing wells instead of fluid injection into the reservoir. If the Bradford field had water conditions similar to those existing in the East Texas field, or if the chronology of the two fields were interchanged, it is believed that the main meaning of the term "secondary recovery" would be synonymous with "water plugging." . . .

One of the most serious results of producing large quantities of water along with oil is the least appreciated. This effect is the drop in pressure of the water which forces the oil into the well. It has been shown that high recoveries in water-flood operations are dependent on high-pressure gradients.[6] The dissipation of water pressure before the stripping stage is reached precludes the possibility of the employment of high natural pressure gradients when they are most needed.

Several excellent accounts[7,8,9] of plug-back operations in various areas have appeared recently. Treatments of the types described have been employed on an increasing number of wells with continued favorable results, using a chemical resembling bakelite in its properties. Most wells require only small volumes of rosin for effective shutoff, averaging about 30 gal. per well. In addition, treatments on a considerable scale have been carried out in several other areas.

In Kansas 88 treatments were performed by one company in the first five months of 1945. Although many of the treatments were highly successful, it is impossible to rate the percentage of success as has been done in the East Texas area: first, because all the data are not available to the writer; and, second, because of the varied purposes of the jobs. The information is sufficient to indicate that the several limestone formations producing in Kansas may be plugged completely, notwithstanding their more open texture and the fact that most wells have been heavily acidized.

In the year ending March 1, 1945, 88 treatments were performed in the Houston district by one company. Jobs which were entirely successful in achieving their purpose and those which accomplished less are about evenly divided. The somewhat lower percentage of success, as compared with the East Texas field, is no doubt due to the relative lack of information of the many sands in the coastal region. . . .

References

1. H. T. Kennedy, "The Control of Gas-Oil and Water-Oil Ratios by Chemical Treatment," Drilling and Production Practice, 214-20 (1941).
2. Haskell, U. S. Patent 2,264,037 (1941); Kennedy, U. S. Patents 2,272,672-3 (1942); Detling, U. S. Patent 2,341,500 (1944); Andresen, U. S. Patent 2,365,039 (1944).
3. S. T. Yuster and J. C. Calhoun, "The Selective Plugging of Oil Sands," Producers M. 8 (70) 31 (1944).
4. Private communication: Report entitled "Progress Report on Selective Plugging with Paracols," Oct. 16 (1944).
5. R. F. Nielson and S. T. Yuster, "Selective Plugging in Air-Gas Drive by Smokes," to be published in an early issue of the Producers M.
6. Calhoun, McCormick, and Yuster, "Effect of Pressure Gradients and Saturation on Recovery in Water Flooding," Producers M. 9 (1) 12 (1944).
7. E. B. Miller, Jr., "Plug-back Work with Plastics," Drilling and Production Practice, 97-103 (1944).
8. "Plastics Now Adapted to Remedial Work in Kansas Wells, The Oil and Gas Journal, 43 (51) 117-21 (1945).
9. Paul Reed, "Special Technique Promises to Change Future Lime Completion Practices," The Oil and Gas Journal, 44 (2) 137-43 (1945).

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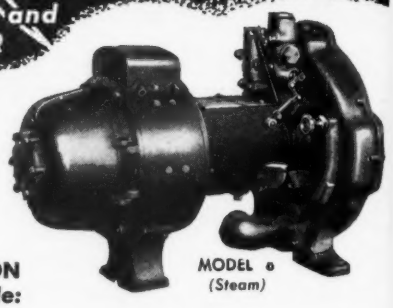

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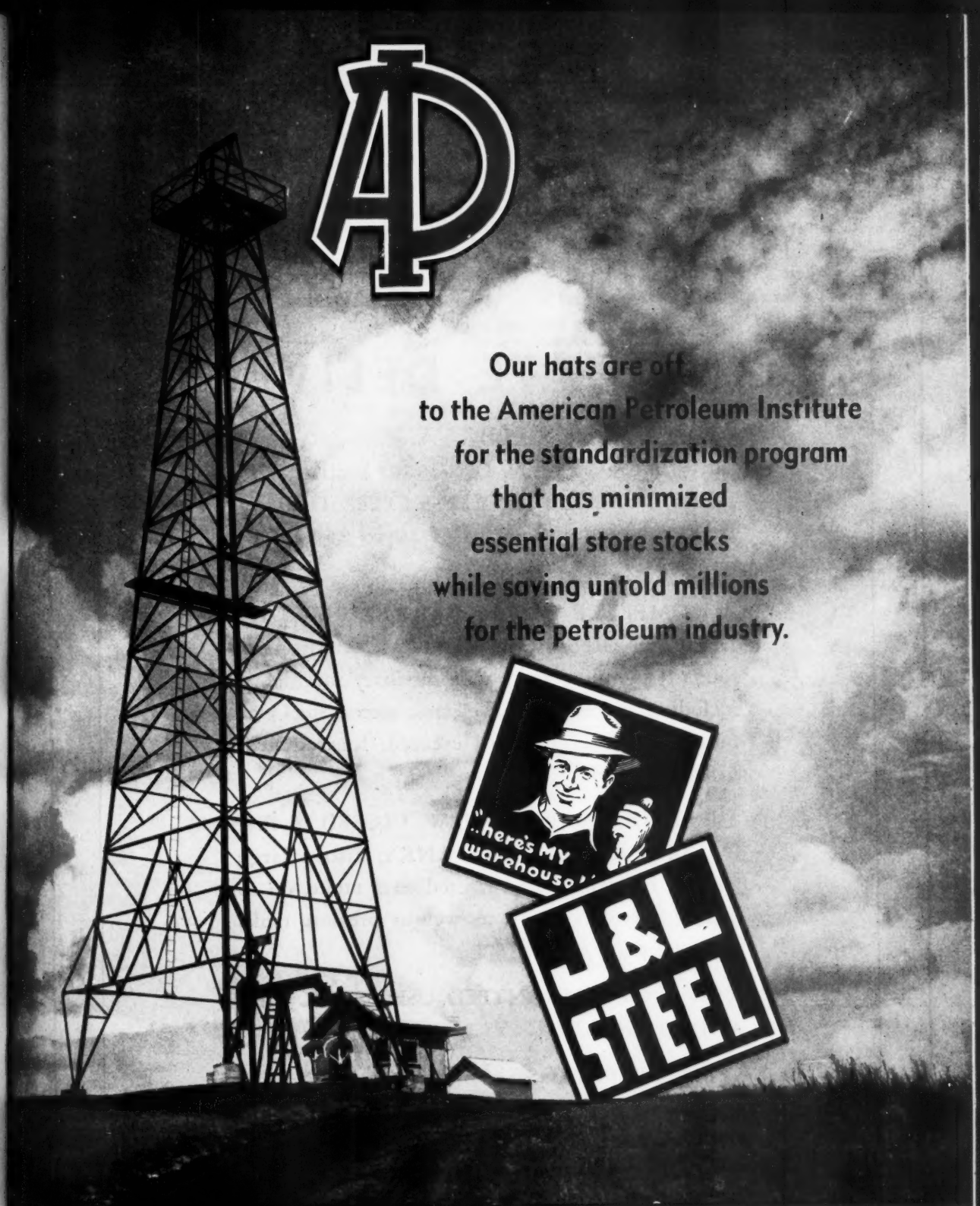

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Five Years of Operating at Langlie Unitized Repressuring Project

by Ralph L. Gray

Five years of operation under a gas-injection program are summarized for the Langlie unitized repressuring project in southeastern New Mexico. It is estimated that recovery by gas injection ultimately will be 43.5 per cent greater than primary operation for injection period, or 14.8 per cent greater for entire life. The author is with Stanolind Oil & Gas Co., Hobbs, N. M.

THE Langlie unitized repressuring project is located in Lea County, New Mexico, in Township 25 South, Range 37 East. It occupies parts of Sections 5, 8, and 9, and is 2 miles north of Jal. The unit was officially started April 1, 1941, for the purpose of instigating a gas-injection program. . . .

The unit (Fig. 1) comprises 2 gas-injection wells and 11 producing oil wells, of which 9 are flowing and 2 are on gas lift. The well density is 1 well to 40 acres. Participants are Anderson-Prichard Oil Corp. (operator), Rosley Oil Co., First Chicago Corp., Western Gas Co., and Stanolind Oil & Gas Co.

Gas for injection is furnished by the El Paso Natural Gas Co., near Jal, at a low cost. This is essentially a service offered by that company to assist in determining the benefits of injecting gas into this reservoir. Gas is treated to remove hydrogen sulfide, and is compressed to about 1,000 psi. All produced gas from the unit is then gathered by El Paso Natural Gas Co. and processed to remove gasoline, butane, and propane. Oil produced is a mixed-base crude with a gravity of 34° A.P.I., having decreased from an original gravity of 38°.

Geology and Reservoir Characteristics

Oil is being produced from lenticular sands of the Lower Seven Rivers or Upper Queen formations (Permian). Sands are intermingled with dolomite and sandy dolomite. These sands range from 5 to 20 ft. in thickness, and are located on the southwest side of a folded anticlinal structure trending northwest - southeast. The oil pay is found at depths of 3,450 to 3,500 ft.

It was necessary to estimate crude characteristics such as bubble point and gas in solution, inasmuch as a bottom-hole sample was never obtained from these wells. Bottom-hole sample data taken from a similar type pool nearby are used to calculate reservoir withdrawals. This assumes a solution ratio of 264 cu. ft. per bbl. at 550 psi. The reservoir is gas-saturated. The reservoir volume factor is 1.17 at 550 psi. The gas-deviation factor is 0.921 at 550 psi. The original reservoir pressure is estimated at 1,400 psi. and repressuring was commenced when the average pressure was about 615 psi. The average pressure on January 1, 1946, was 467 psi. No core data are available but, based on a comparison with similar pools, it is estimated that average porosity is 10 per cent and permeability is 8 millidarcys, although permeability values have a wide range. The pool does not have an effective water drive. Only a small amount of water is produced. It is estimated that the average net feet of oil saturated sand is 10 to 15 ft.

The "A," "B," and "C" sands are the principal oil-producing sands, although there may be as many as five sands furnishing oil in some parts of the unit. It is thought that the "A" sand has been the most prolific and has the highest permeability; a large part of this sand is now highly saturated with gas. Just above sand "A" is a rather thin sand thought to be chiefly gas-saturated. However, this sand probably has some oil in the lower structural position such as a Langlie "A" No. 1 and No. 2, and Stuart No. 3. . . .

Reservoir Performance

In 5 years of operation under gas injection, the average reservoir pressure has declined from 615 to 467 psi., or a decrease of 1 psi. for each 2,870 bbl. of oil produced. Prior to gas injection, pressure was decreased from an estimated 1,400 to 615 psi. in about 3 years. This is a decrease of 1 psi. for every 863 bbl. of oil produced. Fig. 2 shows gas-oil ratio and bottom-hole pressure behavior, and oil and water production, for the entire unit. . . .

In the early stages of unit operation, the average gas-oil ratio increased rather sharply for 1 year, and then assumed a more gentle slope. During the past year remedial measures have been taken to lower gas-oil ratios by resetting packers in both injection wells and injecting gas into lower sands. The ratios were effectively lowered by this means. At the start of unit operation, the average gas-oil ratio was about 2,000 cu. ft. per barrel. After 1 year of gas injection, this increased to about 8,600 cu. ft. per barrel, and since that time maximum average gas-oil ratio has been about 14,000 cu. ft. per barrel. . . .

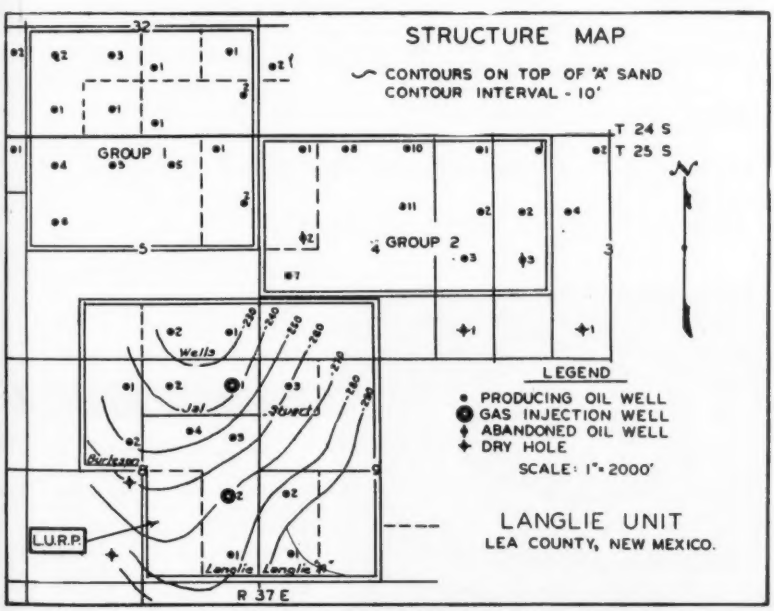

Fig. 1—Structure map—Langlie Unit, Lea County, New Mexico

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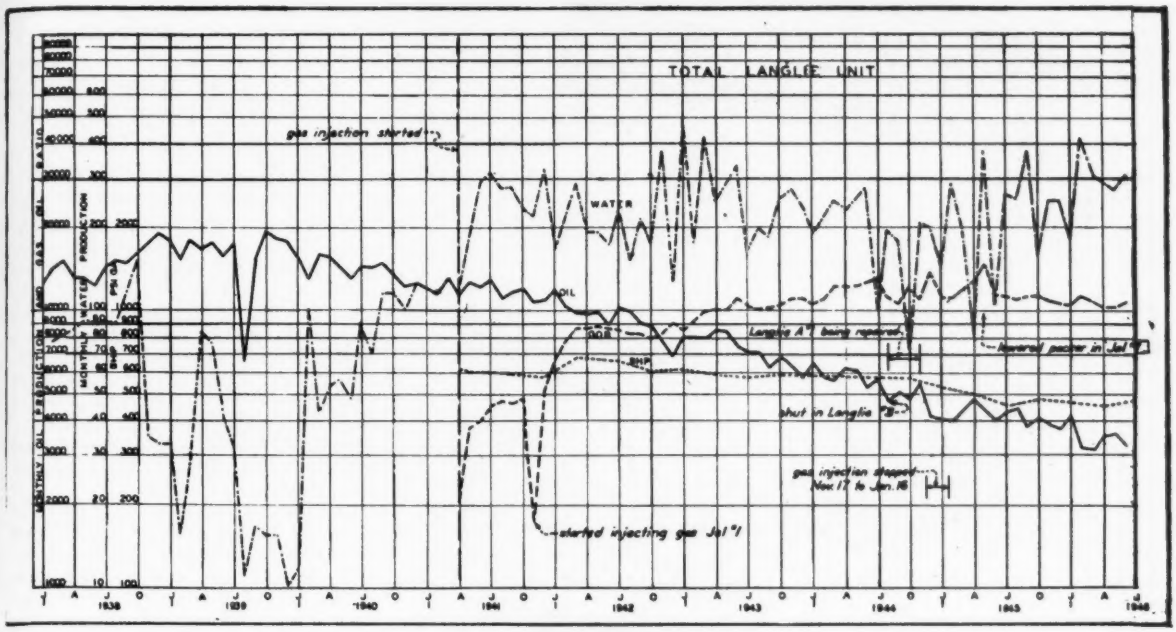


Fig. 2—Gas-oil ratio, bottom-hole pressure; oil and water production—total Langlie Unit

Repressuring Benefits

Referring to Fig. 1, two areas north of the Langlie unit are designated as group 1 and group 2. These two groups, which are presently and always have been produced by primary means, were studied along with the unit to determine benefits due to injecting gas. Wells in all three groups produce from the same geological section of similar thickness and type. Group 1 comprises 14 wells; whereas group 2 embraces 12 wells, of which 2 are nonproductive. Average initial potentials in barrels of oil per day were:

Group 1, 267; group 2, 546; Langlie unit, 335.

Fig. 3 shows a comparison of monthly oil production for the Langlie unit, group 1 and group 2. The last well drilled in the unit was completed in August 1939. The last wells to be completed in groups 1 and 2 were in December 1939. The heavy broken line at April 1941 indicates starting of gas injection in the unit. Prior to injection, production curves merely correspond to allowables. However, shortly following this the producing capacity of most wells declined, and production curves represent the true ability of wells to produce. The production after June 1946 is estimated. . . .

It is expected that the ultimate production of oil will be as follows:

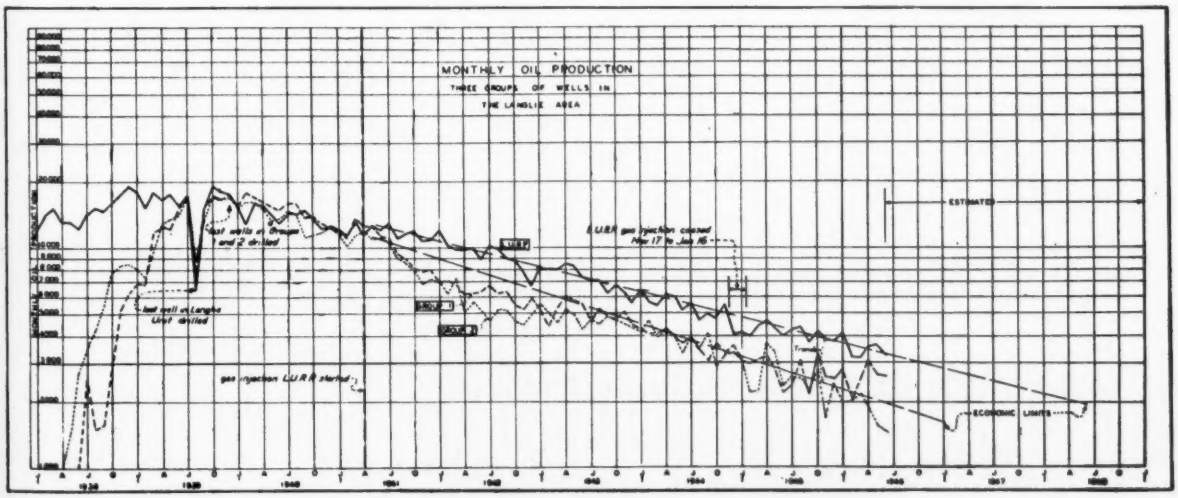
By gas injection — 1,178,864 bbl., or 1,840 bbl. per acre.

By primary means—1,027,214 bbl., or 1,600 bbl. per acre.

Additional oil due to repressuring —151,650 bbl.

As of January 1, 1946, recovery by gas injection was 11.1 per cent greater than primary operation, or 33 per cent greater for injection period. Ultimately, it is estimated that recovery will be 14.8 per cent greater than primary operation for entire life, or 43.3 per cent greater for injection period.

Aside from increasing the recovery of oil, it is apparent that gas injec-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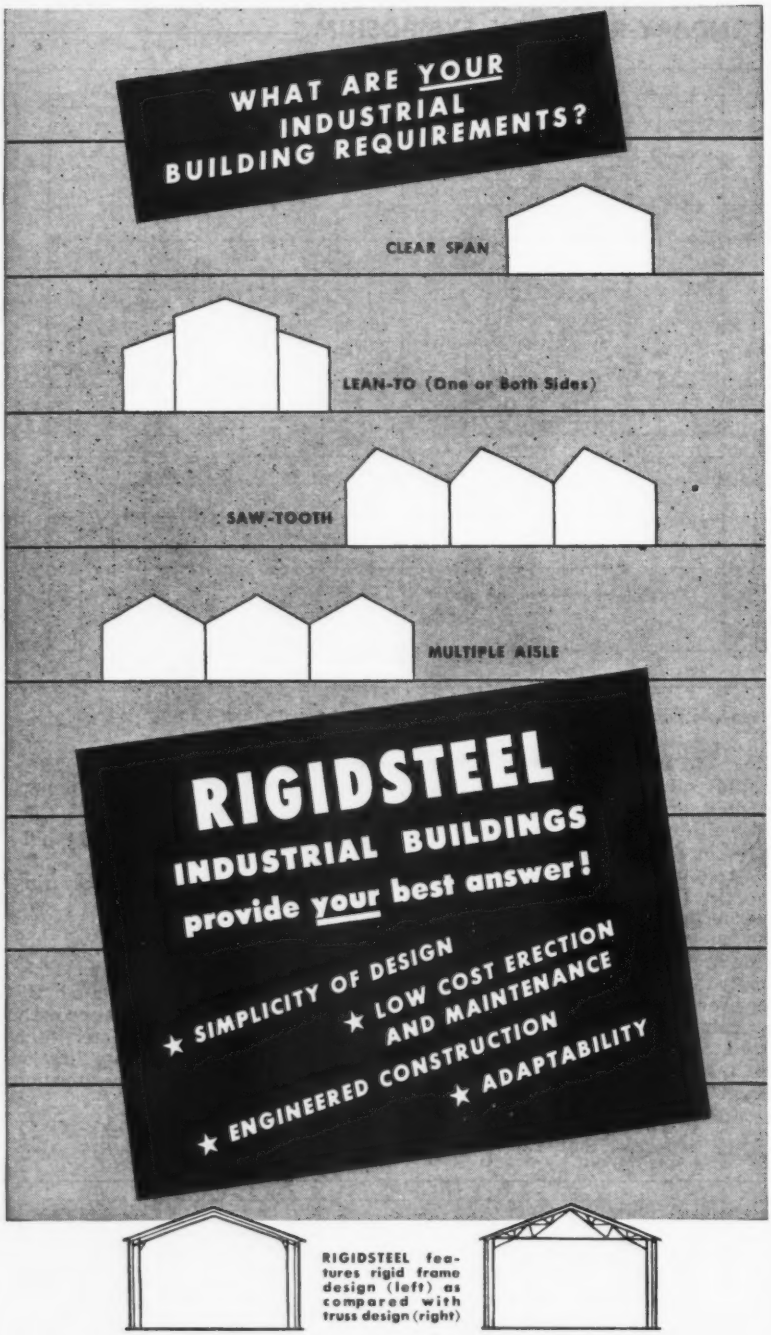
THREE GROUPS OF WELLS IN THE LANGLIE AREA
ESTIMATED
ECONOMIC LIMITS
gas injection L.U.R.A. started
L.U.R.A. gas injection ceased Nov. 17 to Jan. 16

Fig. 3—Monthly oil production — three groups of wells in the Langlie area



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tion has materially reduced investment and operating costs. Following is a tabulation comparing the status of unit wells with groups 1 and 2:

	Pumping	Gas-lift	Flowing	Per cent on artificial lift
Group 1	4	6	4	71.4
Group 2	1	4	5	50.0
L.U.R.P.*	0	2	9	18.2

*Langlie Unitized Repressuring Unit.

By injecting sufficient gas to allow only a small pressure decline, it has been possible to delay the need for artificial lift, and in many cases the need for lifting equipment has been completely eliminated. In two cases, wells in the unit which were pumping prior to gas injection started flowing afterwards. Burleson No. 1 started flowing in April 1942, and Langlie "A" No. 1 started flowing a few months after gas injection had been started. . . .

The greatest problem in 5 years of operation has been in controlling gas-oil ratios. After a few months of operation, it became evident that some channeling of gas was occurring between injection and offset wells. The gas-oil ratio at 2 Jal increased from about 3,000 to 15,000 cu. ft. per barrel in 9 months. Corresponding increases were noted at 3 and 4 Langlie wells. Later it was seen that some of the gas was probably being driven through some upper dry gas sands without coming in contact with oil sands.

During the latter part of 1943 and early part of 1944, an attempt was made to lower gas-oil ratios by injecting crude oil along with injection gas to decrease permeability of formation to gas. Approximately 1 bbl. of crude oil per day was injected over a period of 3 months without showing any effect on gas-oil ratios. In August 1944, 3 Langlie was shut in to conserve gas. At this time it was producing with a gas-oil ratio of 25,000 cu. ft. per barrel. The well was not opened until December 1945, but little benefit was realized, as the gas-oil ratio was still 20,000 to 25,000 cu. ft. per barrel and daily oil production had declined from 15 to 7 bbl. of oil per day.

The most successful method used in reducing gas-oil ratios was in lowering packer into 1 Jal, and injecting gas below the "A" sand and lowering packer into 2 Langlie to inject all gas in "A" and "B" sands. As an example of benefits obtained from these changes, the gas-oil ratio of 2 Jal was lowered from 20,000 to 13,000 cu. ft. per barrel. Ratios were also effectively lowered in 3 and 4 Langlie wells. The greatest benefit from repressuring was obtained at 1 Langlie "A". At start of injection, this well produced 8 bbl. of oil per day by artificial lift. After 6 months of gas injection, the well flowed an average of 42 bbl. of oil per day. . . .

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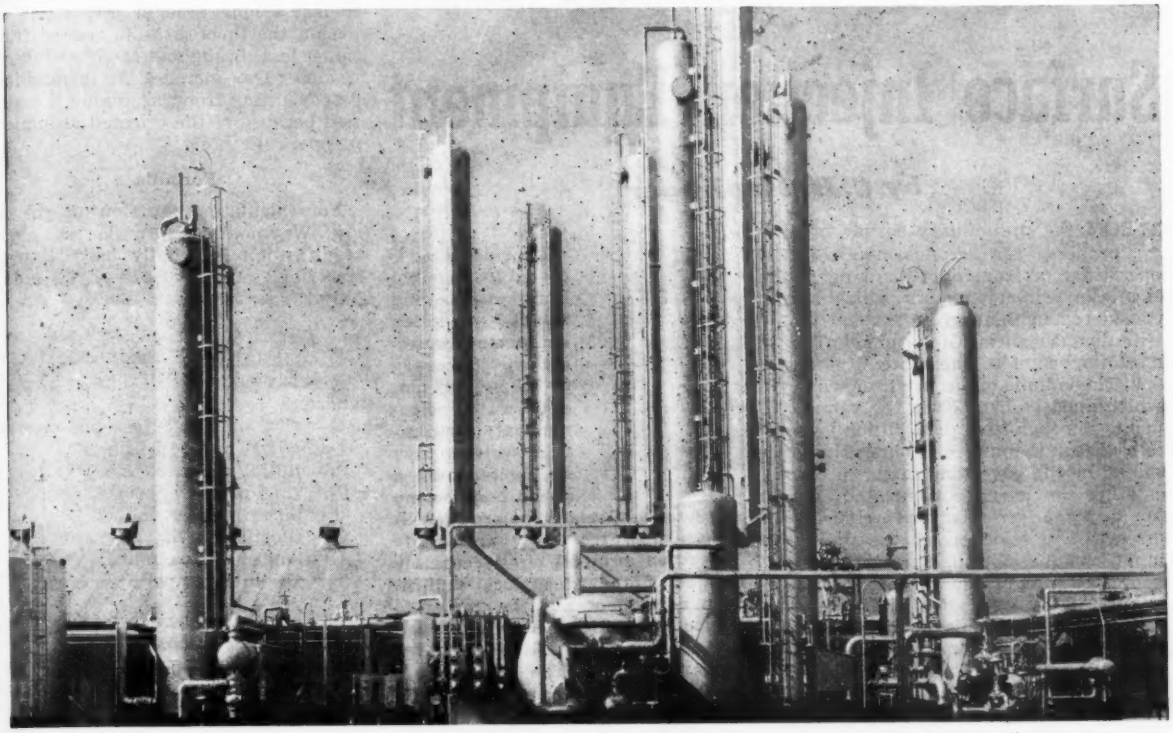

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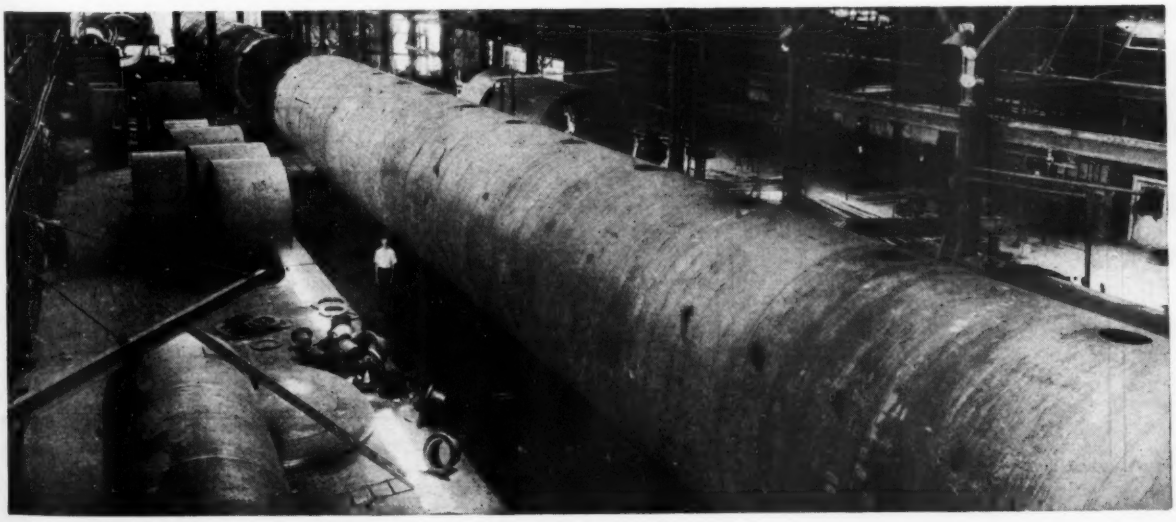

Distribution Systems and Surface Injection Equipment

by C. H. Keplinger

Consideration is given to distribution systems and well - injection equipment for secondary recovery of oil by air, gas, and water. Economical distribution systems may be designed on a sound engineering basis if the important factors such as volumes, pressures, and expected life of proposed projects are accurately estimated. Standard surface well-injection equipment may be varied to meet local conditions. Individual well meter equipment should be provided for every project. The author is a partner in the firm of Keplinger & Wanemacher, Tulsa.

FROM the preliminary survey of a property for secondary-recovery operations or from pilot-plant operation, the primary factors which are considered in the surface system distribution design are determined. The most important of these are:

1. The volume of gas or air or water which must be handled at the various points through the distribution system: The maximum efficient volume should be the governing factor in calculating the most economical design for a given secondary repressuring project. The selection of the proper input volumes throughout the contemplated life of the project should be accurately estimated before the distribution system is designed. For a more detailed treatment of this subject, the reader is referred to Jo H. Cable's paper in American Petroleum Institute's Supplement to Secondary Recovery of Oil in the United States.[1]

2. The pressure which will be necessary to inject the most efficient volume into the producing formation must be estimated. Possible variations in the pressure requirements throughout the life of the repressuring program should be considered. The designer of the system should take into account the maximum pressures which will be experienced to insure efficient operations.

3. The area that will be handled by a distribution system should be closely approximated, and all possibie extensions considered in the original design. The location of the injection wells and their spacing pattern should be determined and made available to the designer of the distribution system, in order for him to determine the length and volume requirements of the various distribution lines.

4. The location of the repressuring plant should be selected on the basis of topography, well distribution, and availability to water or gas supply.

5. Some estimate of the life and rate of return of investment of a secondary-recovery project should be made. On projects which are expected to last a long time, it is possible to design the lines so as to reduce frictional loss throughout the distribution system. The increase in installation cost resulting from large pipe is justified because of the effected reduction in operating costs.

Formula

For calculating the flow of gas or air, Weymouth's formula or some modification is usually used. Extensive field tests have proved its reliability. The formula follows:

$$Q = 15{,}322.47 \left[\frac{(P_1^2 - P_2^2)\, d^{5/3}}{GTL}\right]^{1/2}$$

where:

Q = flow in cubic feet per day at 60° F. and 14.7 psia.
P_1 = initial pressure, psia.
P_2 = final pressure, psia.
d = pipe diameter, in.
G = specific gravity of gas or air.
L = length of line, miles.
T = absolute temperature of gas, °F.

The foregoing formula may be used to determine pressure drops, when volumes are known, by transposing the factors in the formula other than pressure to the left-hand side. It is usually advisable to use nomographs based on the Weymouth formula for expediting the calculations. These are available in several handbooks on natural-gas transmission.

In water-flooding operations, the calculation of the flow through pipes of varying diameter is made by using the Hazen-Williams formula. This formula is as follows:

$$V = 1.318cR^{0.63}S^{0.54}$$

where:

V = mean velocity, feet per second.
R = hydraulic radius, for circular

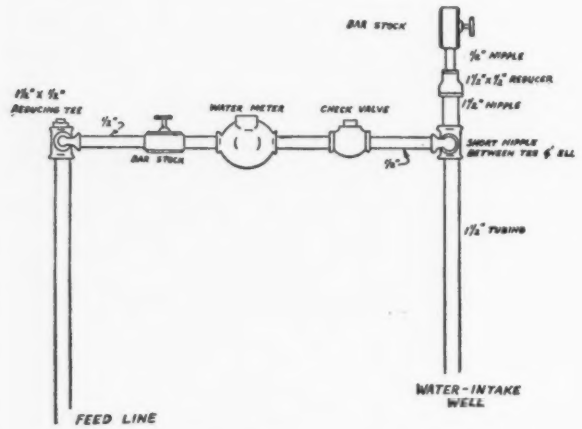

Fig. 1—Hookup of water-input wells

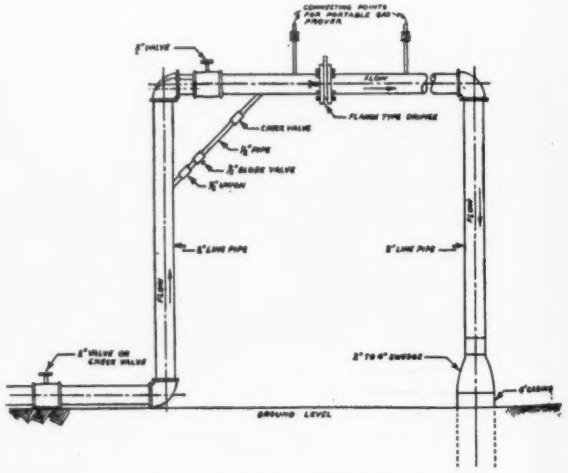

Fig. 2—Hookup of gas-input wells

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S = sine of slope of hydraulic gradient equivalent to pressure head in feet of water, feet per foot.

c = coefficient, depending on roughness of pipe, varies between 100 and 140.

Installation Factors

The distribution system in most common use is the loop system, with individual lateral lines running to the injection wells. This type of installation offers lower initial investment cost. Fan or radial main feeder lines from a centrally located plant with individual lateral lines to the injection wells have proved most economical in some fields. The shape of the area to be repressured is the determining factor. In small projects individual lines from the repressuring plant have been used with success, and offer the possibility of central metering and control, with a resultant savings in operating cost. The size of the distribution lines is selected to provide for a minimum pressure drop between the plant and the injection well. . . .

Surface Injection Equipment—Water Flooding

Surface injection equipment varies from field to field, but usually contains the essential features of a water-recording meter and necessary well-head fittings and valves for proper operations. A common hookup in the Bradford field, Pennsylvania, (furnished by Parke A. Dickey) is shown in Fig. 1). . . . The purpose of the check valve is to prevent the wells from backflowing during periods of plant shutdown. On an old flood where leaks occur frequently, the plant may be down many hours a week. If the wells are allowed to backflow during this period, there is a great loss in reservoir pressure and a corresponding loss in production rate. Certain companies do not leave the meters on the well, but put a nipple in the meter union. Every so often, or at regular intervals, a meter is installed for a day or so, and the rate taken. Recently rotameters have been used for this purpose. Another company installs one meter on a common line to a group of 5 to 10 wells, and takes daily readings. However, the permanent installation of meters provides the only continuous check on the performance of the wells, and they are generally considered a wise investment toward attaining the best results. . . .

Among surface well connections for water flooding which were studied, many had the general features shown in Fig. 1. It is possible that, when the water is scale-forming or contains suspended matter, it would be advisable to install a filter at the well before the meter. In the Cabin Creek pool of Kanawha County, West Virginia, a filter is provided on all injection wells. Addition description of this equipment is contained in the A.P.I. paper entitled "Water Injection in the Cabin Creek Field, West Virginia," by C. F. Terrell.[2]

Surface Injection Equipment—Gas or Air Injection

For gas injection, the surface hookup should include a drip, orifice meter, check valve, and well-head connections to allow for periodic blowing of the well to remove scale. In all projects which have considerable volume of air mixed with the gas, it is very important that the drips be designed so as to provide for the blowing of line scale through the lines. Fig. 2 shows a typical low-pressure gas-injection hookup, which is used in the Mid-Continent area.

For multiple-zone injection in the same well, suitable well-head connections are provided, and separate meters should be provided for each zone. In some areas it is desirable to arrange the surface equipment so that the fluid in the well may be removed by swabbing or gas lift before an attempt is made to inject gas into the formation.

References

1. J. H. Cable, "Preliminary Field Tests for Determining Required Injection Volumes and Pressures," Proc. A.P.I. 24 (IV) 147-50 (1945); also Supplement to Secondary Recovery of Oil in the United States, 147-50 (1942).

2. C. F. Terrell, "Water Injection in the Cabin Creek Field, West Virginia," Drilling and Production Practice, 77-83, American Petroleum Institute (1945).

Use of Explosives

by R. C. Earlougher

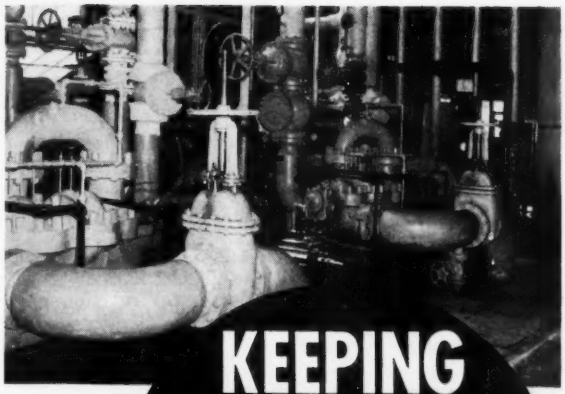
Although the oil sand in all wells is shot in the majority of operations, some floods have been developed without shooting, and are apparently obtaining successful results. The question of whether the sand should be shot is probably dependent upon the sand structure and characteristics in individual fields or areas. The author is head of Earlougher Engineering, Tulsa.

IN almost all secondary-recovery developments where oil production is obtained from sandstone formations, it is common practice to shoot the pay strata in both the injection and production wells. This practice has followed procedure used in the early days of the industry when it was found that most new wells would produce oil at higher rates after being shot with nitroglycerin. . . . Field data and numerous tests substantiate the fact that, in cases where shooting does greatly increase the productivity of a producer or the injectivity of an input well, the result obtained must be by way of radial fractures, and not by increase of hole size alone. In effect, however, these fractures appear to give the same result as an increase in hole diameter to as much as 50 ft.

If permeability of the sand is low as in Bradford, shooting—and heavy shooting at that—is necessary. Even though the depth is sufficient to permit surface injection pressures of as high as 1,500 to 2,000 psi., the sand is so tight (average 5 to 10 md.) that, even with shot concentrations of as high as 5 qt. per ft., satisfactory injection rates cannot always be obtained. On the other hand, if the permeability were a great deal higher, it is probable that shooting would not be necessary other than for the purpose of selective shooting. . . .

Selective shooting based on individual well cores has now been in use on a rather wide scale by many operators for 6 to 8 years. In most cases where it has been used, it has proved advantageous in increasing economic oil recovery and at the same time reducing over-all "water-injection to produced-oil" ratios. Increase in oil recovery, of course, results in increased gross income, whereas reduction in "injected-water to produced-oil ratios" results in reduced operating costs. . . . In planning a selective shot, however, the factor of oil and water saturation must be considered in addition to permeability. This is especially true in old fields where there are a number of old abandoned wells, any one of which may have been a leaker resulting in accidental water drives in certain areas under a lease.

The effect of a shot in different wells apparently depends to a large extent upon the physical characteristics of the sandstone itself. . . . as shown by Bradford and Mid-Continent experiences.



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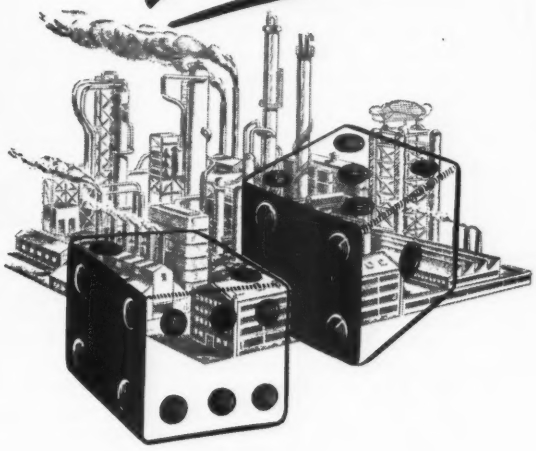

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Utilization of Old Wells

by W. A. Heath

DEPOSITION of paraffin or asphaltic residues on the reservoir wall, or in the pores of the reservoir in the vicinity of the well bore, has been advanced as one of the chief difficulties in the use of old wells—particularly for injection purposes.

Deposition of residues is caused mainly by loss of the lighter constituents due to decrease of pressure, aided perhaps by the alternate exposing of the formation well-faces.[1]

Precipitation of mineral salts on the reservoir wall, consisting primarily of calcium carbonate, or barium, strontium, or calcium sulfate (gypsum) is occasionally encountered in old wells. This precipitation usually results from the mixing of formation water with upper waters entering the well through casing leaks; however, deposition of carbonate may occur by release of carbon dioxide due to reduction of pressure as the formation water enters the well bore.

Gas or barren zones, which may exist at the top of the oil pay, are ordinarily not cased off in the old wells. If the old wells have been shot, the walls of the formation are usually too irregular to permit successful setting of packers to exclude these zones. Such zones may be detected by core analysis in new wells, and may be "cased off" in order to obtain the maximum efficiency of the injection medium.

Bottom-water zones, in which the pressure is exhausted and the water is lying dormant in the lower portion of the formation, also present difficulties in old wells—both in recognition of this condition, if not discernible from lease or well records, and in plugging off the zone in wells which have been shot.

Early practices in completing old wells drilled with cable tools consisted of setting the oil string at some distance above the top of the sand—both for the purpose of obtaining a good "seat" for the casing, which was usually not cemented, and of facilitating shooting of the reservoir rock without damaging the casing or seat. Quite commonly in certain areas, "thief" zones, such as coal or lignite seams or fractured formations, are exposed in the interval between the casing seat and the top of the producing formation. These zones accept water readily unless isolated from the injection medium by casing, or tubing and packer. Even though no thief zone is present, an expenditure

Prime advantage of using old wells is a large saving in development cost. Disadvantages consist of irregular spacing, poor mechanical condition of the well bore, exposed gas, or thief formations which may be difficult to isolate because of having been shot with nitroglycerin.

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is necessary to recondition a well for water-injection purposes in cementing the casing seat to prevent circulation of the injected water. Gas-injection wells ordinarily do not require cementing of casing seats, as injection pressures are lower than in water-injection wells.

Water intrusion into the resorvoir in old wells, creating a "water-logged" condition of the sand body surrounding the wells, is another problem occasionally encountered. This condition is frequently the result of leaky casing or faulty casing seats. If any appreciable amount of water has entered the reservoir, the well can never be utilized as a producing well in secondary-recovery projects with satisfactory results.[2,3] This is manifested by specific instances in practically every area of the country where secondary-recovery operations are conducted. If only a small amount of water has entered the well bore to cause a water-logged condition in the immediate vicinity of the well, the injection of oil or gas into the well to dissipate the water and increase the permeability of the reservoir rock to the hydrocarbon fluid phase is recommended before an attempt is made to use such well as a producer. Water-logged wells can, however, usually be used as input wells. . . .

Reconditioning of Old Wells

The essential purposes of reconditioning old wells in conversion to input wells are:

1. To remove obstructions from the well bore or reservoir wall which would prevent or deter the input medium from penetrating the reservoir.

2. To confine, insofar as possible, the input medium solely to the pay section, where the maximum useful work will be done.

Methods used to clean the reservoir wall or shot hole of old wells have been discussed by Reistle,[1] Taylor,[4] Shea[5] and others. Such methods are as follows:

1. Cleanout tools.
2. Shooting: (a) Nitroglycerin; (b) marble.
3. Application of heat: (a) Steaming; (b) hot-air circulation; (c) carbide; (d) berite; (e) reaction of sodium hydroxide or acids on metals; (f) electrical element; (g) down-hole fire.
4. Paraffin solvents.
5. Acids: (a) Hydrochloric; (b) mud.

Cementing of casing seats to prevent injected water from circulating behind the casing is accomplished by setting a bridge below the seat to prevent the cement from going into the pay formation. In the event the hole below the seat is enlarged to the extent that a bridging plug cannot be set, the hole is filled with sand or gravel with Calseal serving as a cap. . .

The question of proper rates of travel of the injection medium through the producing formation enters into the problem of intensity of development which is inherently associated with the use of old wells. In practice, daily water-injection rates vary from 1 to 20 bbl. per vertical foot of sand, and daily gas-injection rates from 500 to 20,000 cu. ft. per vertical foot at standard conditions. For the scope of this paper it must be assumed that in each specific case the rate is "correct," and that the rate was determined by technological considerations of reservoir conditions. However, it is quite likely that individual opinions account for the widespread divergence in injection rates. The use of injection rates of "1,000 cu. ft. of gas" or "2 bbl. of water" per vertical foot of sand—because such rates were commonly applied elsewhere — has frequently caused discouraging results in new areas. Many projects using old wells and wide spacing have been classified as failures because injection rates were too low to give adequate results within reasonable time.

References

1. C. A. Reistle, Jr., "Paraffin and Congealing—Oil Problems," U. S. Bur. Mines Bull. 348 (1932).

2. H. M. Ryder, "The Economic Technology of the Water Drive—Its Application to Encroachment Water and Water Flooding through Oil Sands," A.P.I. Division of Production, Tulsa meeting, Paper 851-16C, Mar. 27 (1942).

3. R. C. Earlougher, "Controlled Water-Flood Development and Operations in Mid-Continent," A.P.I. Division of Production, Los Angeles meeting, Paper 801-20F, Mar. 23 (1944).

4. S. S. Taylor, "Wartime Application of Air-Gas Injection and Oil-Well Reconditioning in the Appalachian Region," U. S. Bur. Mines, R.I. 3777, 27-38 (1944).

5. G. B. Shea, "Some Tools and Methods Used in Cleaning Oil Wells in California," U. S. Bur. Mines, R.I. 3706 (1943).

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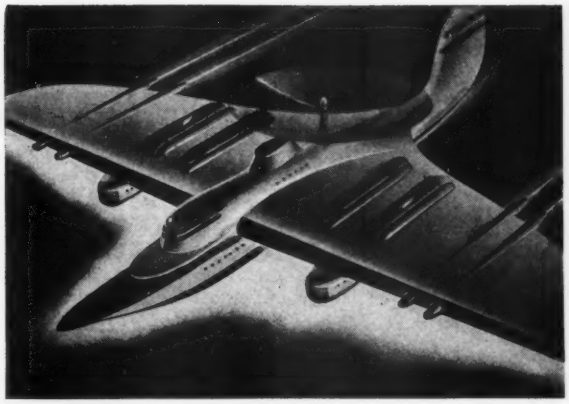

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Source and Purification Of Gas Supply

by L. L. McWilliams

NATURAL gas is the most widely used injection medium. Air has been used where there was an insufficient supply of natural gas, or where the price was excessive. The preponderance of evidence is against the use of air. Some rarely used media are manufactured fuel and inert gas, engine-exhaust gas, and propane or butane hydrocarbons. . . .

The source of most gas for a project is usually from producing wells in the project. Quite often an outside source of "makeup" gas is required In either case there are many items to be investigated with respect to a source of gas. The A.P.I. Subcommittee on Secondary-Recovery Methods[1] has outlined the requirements to be investigated.

This paper covers types and sources of gas for injection; outlines methods of testing for undesirable gases and methods to purify by elimination or reduction. The author is associated with Phillips Petroleum Co., Bartlesville, Okla.

Undesirable Injection Media

The commonly recognized undesirable gases incident to gas-injection projects are hydrogen sulfide (H_2S), carbon dioxide (CO_2), oxygen (O_2), and water vapors.

Air may enter the system, and certain disadvantages will result. Some work on the subject has been published by the U. S. Bureau of Mines.[2] Conclusions of tests were that, when crude oils were oxidized, the following results may be expected:

"1. Carbon dioxide (CO_2) is produced.

"2. Asphaltic materials and gums insoluble in the crude are formed.

"3. Acid values increase.

"4. Surface tensions remain virtually the same.

"5. Interfacial tensions decrease.

"6. Water-flooding tests with sand cores will indicate decreased production due to formation of emulsion.

"7. Tests of rates of flow of the oxidized oil through sand cores will indicate plugging.

"The magnitude of these changes depends upon:

"1. The chemical individuality of the crude.

"2. The degree of oxidation, which depends upon such factors as time, contact, temperature, and concentration of oxygen.

"In general, the resistance of the crude oils studied toward oxidation decreased in the following order: paraffin-base; intermediate-base; and naphthene-base."

When air comes in contact with equipment in the presence of water, corrosion can result. Iron oxide, or "rust," is often present. Rust may form on the oil string and drop into the input-well bore, thus causing plugging. Leaky casing and the possible intrusion of water into the input well can develop.

Others[3,4,5,6,7] have covered the subject of air injection, giving some actual field observations.

Severe difficulties can develop when hydrogen sulfide is present in the injection media. The U. S. Bureau of Mines[8] has made several conclusions regarding corrosion of steel by gases containing traces of hydrogen sulfide, some of which are listed:

"Two forms of corrosion have been identified.

"(a) A less serious form, ordinary gaseous corrosion, in which no precipitated water is present on the surface of the metal, although the gas may be saturated with water vapor.

"(b) A severe form, modified gaseous corrosion, in which precipitated water is present on the surface of the metal.

"Pressure accelerates the reaction in both forms of corrosion, but this effect is particularly noticeable with modified gaseous corrosion.

"The 'corrosion threshold concentration' of hydrogen sulfide, or the amount necessary for producing severe corrosion, is lower for modified gaseous corrosion than for ordinary gaseous corrosion.

"Modified gaseous corrosion appears to be the result of an electrochemical reaction, while ordinary gaseous corrosion has the characteristics of a chemical attack.". . .

The secondary-recovery engineer is interested in the degree of corrosion that would be caused by the occurrence of hydrogen sulfide in the injection medium. The U. S. Bureau of Mines[8,9] has published experimental data which should be helpful in estimating the life of pipe lines carrying sour gas. . . .

Hydrogen Sulfide

The A.P.I. code [10] recognizes two methods for the testing of hydrogen sulfide:

(a) Tutweiler methods.[11]—For analyzing natural gases where the hydrogen-sulfide content is in excess of 20 grains per 100 cu. ft. of gas. The so-called 100-ml. Tutweiler is recommended in the A.P.I. code for these measurements. However, a 500-ml. Tutweiler is sometimes used to measure hydrogen-sulfide content in the range of 1 to 20 grains per 100 cu. ft. of gas.

(b) Cadmium-sulfate method.[10]—For analyzing natural gases where the hydrogen-sulfide content is less than 20 grains per 100 cu. ft. of gas, although it may be used in place of the Tutweiler method for higher content.

For a quick qualitative field test, the lead-acetate method may be used. Moist lead-acetate paper is exposed to the gas for testing. If hydrogen sulfide is present, the paper will be discolored—turning light brown to black, depending on the hydrogen-sulfide content and the length of time exposed. Some mercaptans may produce a yellow color, but will disappear in a short time if exposed to sunlight.

Carbon Dioxide and Oxygen

The Orsat apparatus[11] is commonly used for determining carbon-dioxide and oxygen content. The method is recognized in the A.P.I. code.[10] The principle of this method is to pass a given quantity of gas first through a solution of potassium hydroxide to remove the carbon dioxide. Next the gas is passed through a solution of alkaline pyrogallol to remove the oxygen. Both the oxygen and carbon dioxide are measured in terms of per cent by volume. Air content of the gas can be determined as five times the oxygen content. If hydrogen sulfide is present in the gas, it will be removed in the testing process along with carbon dioxide. Consequently, the per cent of hydrogen-sulfide content must be determined by one of the methods previously discussed and deducted from the carbon-dioxide - hydrogen - sulfide content found by Orsat analysis. . . .

Water vapors

Gas as it emerges from a producing well, or from a gasoline plant or

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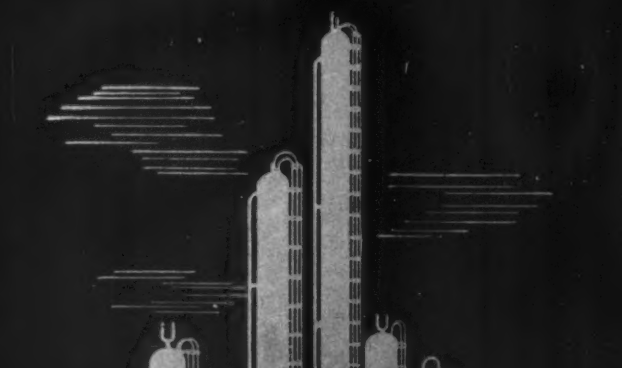

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booster station (before dehydration), is generally conceded to be fully saturated with water vapors. The water vapors will condense with a reduction of temperature or an increase of pressure. The temperature at which liquid water begins to form is termed the "dew point." Under certain conditions of pressure and temperature the condensed water vapors may freeze. Usually most freezing troubles result from the formation of gas "hydrates," as they may form far above the freezing point of pure water. By way of explanation, a hydrate[12] may be defined as a chemical compound in which water is present in fixed and simple molecular proportions. The natural-gas hydrocarbons that will form hydrates are methane, ethane, propane, and isobutane.[12] The natural-gas hydrates will be solid compounds resembling snow or ice in appearance. The chemical formula for a gas hydrate—e.g., of propane—is $C_3H_8 \cdot 6H_2O$.

The actual taking of dew-point measurements is seldom required. Physical measurements are made by the U. S. Bureau of Mines' dew-point apparatus[14]—the dew point being determined under pressure.

The secondary-recovery engineer often has the typical problem of determining if hydrate trouble will develop when natural gas, as the injection medium, leaves a gasoline plant or booster, and is conveyed through a distribution system to input wells. The determination can be made by actual computation. Katz[13] has presented a simplified approximate method involving the use of graph data. The data are especially helpful, as the graphs cover a range of gas gravities from 0.6 to 1.0. One of the graphs presented by Katz illustrates the conditions of temperature and minimum pressure where hydrates will form, provided sufficient water is present and the mixture is at equilibrium. The following tabulation, derived from the Katz data, illustrates several conditions where hydrates would form:

Gas gravity	Temp. (°F.)	Pressure above which hydrates will form (psi. abs.)
0.6	32	145
0.6	50	475
0.6	70	2,400
0.8	32	75
0.8	50	275
0.8	70	1,800
1.0	32	50
1.0	50	195
1.0	70	1,350

Methods of Purification

Desulfurization—Batch Methods

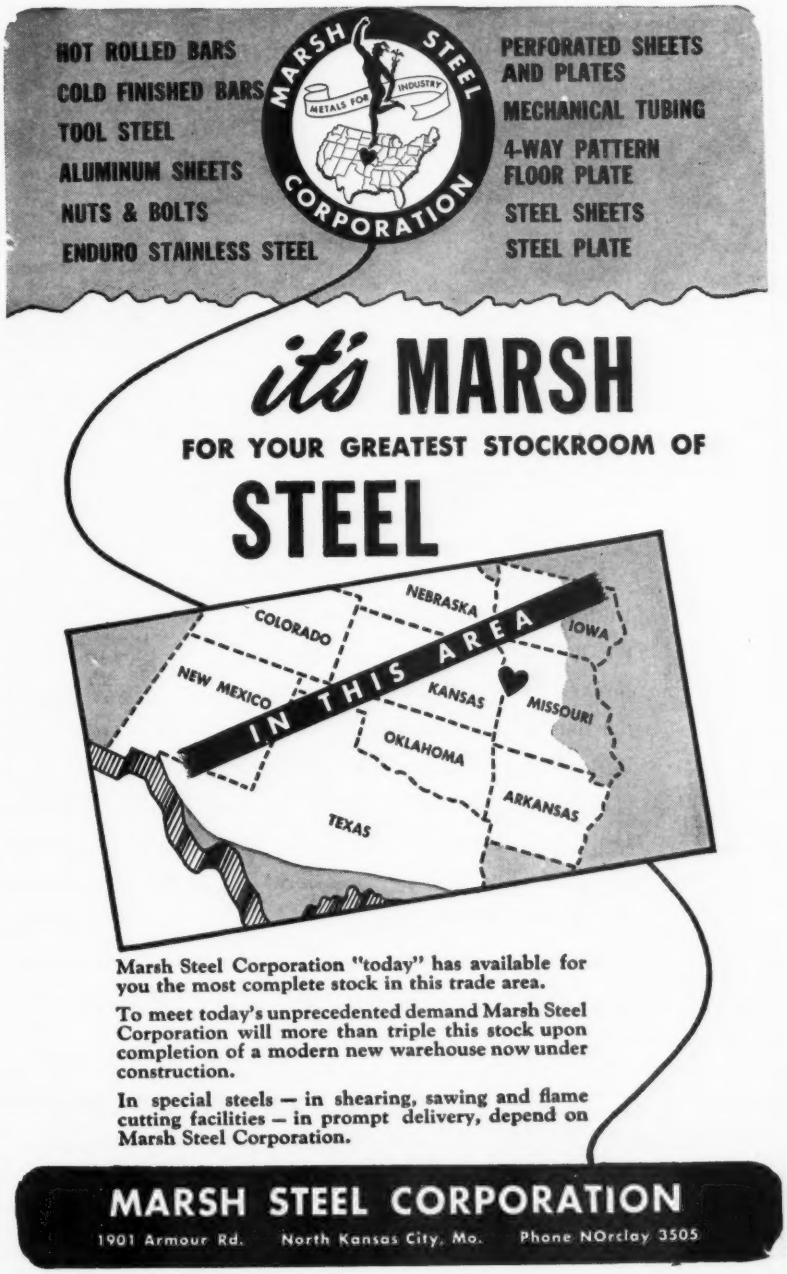
(a) Caustic soda.—The gas is bubbled through a solution of caustic soda (sodium hydroxide) to remove hydrogen sulfide. Usually no attempt is made to regenerate the foul solution. The method is expensive, and is confined to low-volume treating, e.g., in field camps.

(b) Iron oxide.—In this process the gas stream is passed through a tower containing a bed of sponge iron or its equivalent. A small amount of soda-ash (sodium-carbonate) solution is usually passed through the bed to keep it moist and to aid in removing hydrogen sulfide. The iron oxide deoxides into iron sulfide. The process is sometimes regenerated by blowing the tower with air or exposing the iron sulfide to the air. . . . It is one of the earlier methods of desulfurization, of limited application.

Desulfurization—Continuous Methods

(a) Lime - salt (calcium - hydroxide and sodium - chloride) solution.[16]—A solution of lime alone will remove hydrogen sulfide from natural gas, but the solubility of lime in water is small; thus, it is advantageous to use a solution of salt and lime, as a greater amount of lime can be brought into contact with the gas. This is one of the earliest developed methods, and is not in general use.

(b) Soda-ash (sodium-carbonate) solution.[15]—The absorption of hydrogen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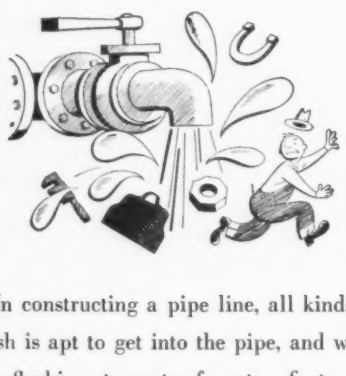
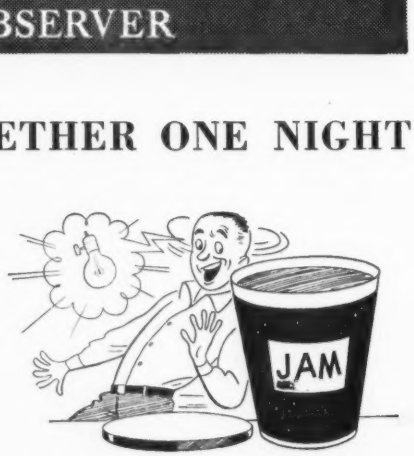


In constructing a pipe line, all kinds of trash is apt to get into the pipe, and when the flushing torrent of water first goes through, some of this trash is washed into the slots or depressions under the valves. Rocks, bits of welding material, or anything hard would cause the failure of the valve to seat tightly. Usually, therefore, the valve has to be taken apart and cleaned out — a time-consuming operation.

Well, it was one of those situations that had waited long enough to be cured by a



bright idea. And the men on the job, sitting around one night discussing the details of the day's work, got around to this one. Maybe it was Bill Chandler, who has since been sent to Arabia, who came up with the jewel of thought. Maybe it was Fred Hampton, construction engineer who followed him. Or maybe it was some hero who will be forever unsung. Somebody said, "Why not fill the depression, or valve-seat, with grease?"

It was done. Grease, topped off with paraffine just as mother tops off a glass of jelly. Not a chunk of welding metal, not a pebble, boulder, lost lunch box, suspender buckle or old shoe could wash into those recesses. When the pipe line had been flushed out, and the valves were tried, up squeezed the grease and out, clean as a hound's tooth. And the valves were tight!

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sulfide results in an increase in the sodium-bicarbonate and sodium-hydrogen-sulfide concentration in the solution, and a decrease in the carbonate concentration. The foul solution is usually regenerated by the use of an actifier in which air or steam carries off the hydrogen sulfide, together with a small amount of carbon dioxide originally absorbed from the gas. To remove virtually all of the hydrogen sulfide usually requires two stages of treating. There are a number of installations of this type of desulfurizer in use.

(c) Sodium phenolate.[17] — Sodium-hydroxide-alkaline solution, by the addition of certain acid phenols, becomes sodium phenolate. In the treating process the sodium phenolate combines with the hydrogen sulfide to form sodium hydrosulfide and phenol. The reaction is reversed by the application of heat, and the hydrogen sulfide can be liberated. The use of a solution, containing in combination an absorption agent (sodium hydroxide) and an auxiliary acidic constituent (phenol), permits a wide flexibility in the choice of solution for any given set of operating conditions. A two-stage process has been recommended in cases where virtually complete removal of hydrogen sulfide is required. The use of sodium phenolate is an advancement over the soda-ash method.

(d) Amines.[18]—The amine groups in general use are as follows:

Monethanolamine (MEA)
Diethanolamine (DEA)
Triethanolamine (TEA)

The compounds will combine with hydrogen sulfide to form amine hydrosulfide. The reaction is reversible with the application of heat to the foul solution, and the hydrogen sulfide can be liberated. Carbon dioxide is also removed. The amine compounds have different characteristics as to reacting capacity, decomposition temperature, heat required for regeneration, and selectivity to hydrogen sulfide instead of carbon dioxide. When air enters the system, the oxygen in the air chemically combines with the hydrogen sulfide in the amine solution to form stable amine—thiosulfate. This compound will in time accumulate to sufficient concentration to reduce the efficiency of the amine solution. This difficulty should be foreseen, and proper equipment can be installed in conjunction with the desulfurizer to overcome this situation. The virtual removal of hydrogen sulfide by the use of amines may be accomplished in one stage. The preponderance of installations of the amine-type desulfurizer, in place and planned, indicates a preference to this method.

In any type of treating installation it may be preferable to desulfurize the gas at the inlet of the gasoline or booster plant in order to reduce or eliminate corrosion of boosting equipment.

Dehydration

The objective of dehydration is to lower the dew point of the gas to where freezing of hydrates or free water will not occur. Prevention of freezing may sometimes be accomplished without dehydration by other means as follows:

1. Use of hot gas direct from the booster without cooling.
2. Improved cooling of the gas to remove water.
3. Additional compression, cooling, and expansion to desired line pressure.
4. Installation of heaters at or near points where freezing occurs.
5. Expansion of gas downhole at the input well by the use of bottom-hole chokes.
6. Burying of distribution lines and protection of surface connections from exposure.
7. Use of drips to remove water and heavier hydrocarbons.
8. Thawing of lines when freezing occurs.

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9. Injection of a chemical into the gas stream to lower the hydrate-forming temperature of the gas.

10. A combination of more than one of the foregoing methods often has an application.

There are a number of drying agents and dehydration processes which could have an application in secondary-recovery work. Hammerschmidt[20] groups several methods as follows:

1. Liquid absorbents
Lithium chloride
Zinc chloride
Dow-8A (calcium bromide — calcium chloride)
Zinc chloride
Diethylene glycol,[21] 96 per cent
Calcium chloride, 40 per cent; glycerin, 20 per cent
Glycerin 85 per cent
Calcium chloride, 40 per cent

2. Solid absorbents
Calcium-chloride lumps
Potassium-hydroxide lumps

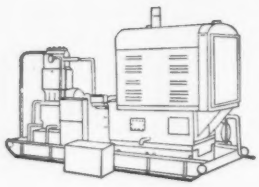
3. Solid adsorbents
Silica gel
Activated alumina
Anhydrous calcium sulfate (drierite)
Florite[22] (bauxite)

The formation of large projects is advisable to obtain a lower cost per unit volume of gas. Conversely, the cost of purification in many potential small projects is so high that gas-injection possibilities are out of the question.

References

1. "The Criteria for Determining Oil Fields' Susceptibility to Secondard-Recovery Methods," Proc. A.P.I. 24 [IV] 143-6 (1943).
2. S. S. Taylor and H. M. Smith, "Summary of Experimental Data on Laboratory Oxidation of Crude Oils, with Particular Reference to Air Repressuring," U. S. Bur. Mines, R. I. 3238 (1934).
3. R. C. Conine, "Gas Used to Repressure Pennsylvania Field in Lieu of Either Air or Water," The Oil and Gas Journal 34 [19] 41 (1935).
4. E. H. Tollefson, "Gas and Air Repressuring," Oil Weekly 89 [7] 64 (1938).
5. H. C. Miller, "Air and Gas Injection Into Oil-Producing Properties," Proc. A.P.I. 10 [IV] 54 (1929).
6. H. C. Miller, Function of Natural Gas in the Production of Oil, Report by the U. S. Bur. Mines and A.P.I., 139, 192, and 215 (1929).
7. H. B. Hill, "Results of Air Repressuring and Engineering Study of Williams Pool, Putnam-Moran District, Callahan County, Texas," U. S. Bur. Mines, T.P. 470 (1930).
8. John M. Devine, C. J. Wilhelm, and Ludwig Schmidt, "Corrosion of Steel by Gases Containing Traces of Hydrogen Sulfide: Effect of Pressure and Moisture Conditions," U. S. Bur. Mines, T.P. 560 (1933).
9. John M. Devine, C. J. Wilhelm and Ludwig Schmidt, "The Effect of Oxygen on Gaseous Hydrogen-Sulfide Corrosion of Tank Steel," U. S. Bur. Mines, R. I. 3160 (1932).
10. A.P.I. Code No. 50-A, 2nd edn., Sect. 5, 25 (1942).
11. Gas Chemists Handbook, 3rd edn., Chap. 3, Am. Gas Assoc. (includes test procedure for determining carbon dioxide and oxygen in natural gas) (1929).
12. E. G. Hammerschmidt, "Gas Hydrates," Am. Gas Assoc., Natural Gas Sect. (1939).
13. D. L. Katz, "Predictions of Conditions for Hydrate Formation in Natural Gases," Am. Inst. Mining Met. Engrs. Petroleum Technology (TP 1748) (1944); Petroleum Engr., reference annual 16 [10] 223 (1945); Natural Gasoline Men's Assoc. (1946).
14. W. M. Deaton and E. M. Frost, "Bureau of Mines Apparatus for Determining the Dew Point of Gases under Pressure," U. S. Bur. Mines T.P. 3399 (1938).
15. D. L. Jacobson, "H_2S Only Need Be Removed From Gas," The Oil and Gas Journal 27 [46] 116 (1929).
16. Harold P. Rue, "The Use of Lime in a Salt Solution for Removing Hydrogen Sulfide From Natural Gas," U. S. Bur. Mines, R. I. 3178 (1932).
17. G. M. Carvlin, "Use of Sodium Phenolate for Hydrogen-Sulfide Removal," The Oil and Gas Journal 37 [2] 56 (1938).
18. W. R. Wood and B. D. Storrs, "Removal of Hydrogen Sulfide From Refinery Gases by Girbotol Process," The Oil and Gas Journal 37 [2] 47 (1938).
19. E. G. Hammerchmidt, "Preventing and Removing Gas-Hydrate Formations in Natural-Gas Pipe Lines," Am. Gas Assoc., Natural Gas Sect. (1939).
20. E. G. Hammerschmidt, "Elimination of Hydrate Troubles," The Oil and Gas Journal 39 [2] 61 (1940).
21. N. K. Senatoroff, "Application of Diethylene-Glycol-Water Solution for Dehydration of Natural Gas," The Oil and Gas Journal 44 [32] 98 (1945).
22. Floridan Co., "Report on Florite Desiccant," Report No. 81, Nov. 4 (1943).

Story of 2 Engines



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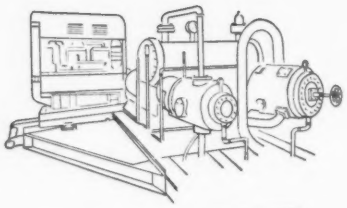

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Built in three basic models: oil pressure only, temperature only and the combination model (illustrated).

A ruined compressor . . . damaged engine . . . lost production . . . wasted man-hours! One superintendent had this expensive story to report . . . because a minor engine trouble went undetected and was allowed to grow into a major breakdown.

The other superintendent *played it safe.* A PENN Safety Control stood watch over his engine . . . ready to warn him the instant oil pressure dropped dangerously low or jacket water temperature rose too high. Little engine faults were speedily found and corrected.

You can play it safe, too! Get the full details of this efficient, low-cost protection from *Penn Electric Switch Co., Goshen, Ind.* Export Division: 13 E. 40th St., New York 16, U.S.A. In Canada: Penn Controls, Ltd., Toronto, Ontario.

Typical Functions of PENN Safety Controls

DIESEL APPLICATIONS. Sounds an alarm only. closes magnetic fuel valve and sounds alarm . . . closes magnetic fuel valve only . . . closes magnetic fuel valve and opens pilot relay.

BATTERY IGNITION APPLICATIONS. Opens battery circuit and sounds an alarm . . . sounds an alarm only . . . opens battery circuit only.

MAGNETO IGNITION APPLICATIONS. Sounds an alarm only . . . grounds single or dual magneto . . . grounds magneto and sounds an alarm or lights a signal light.

DUAL IGNITION APPLICATIONS. Opens battery circuit and grounds magneto.

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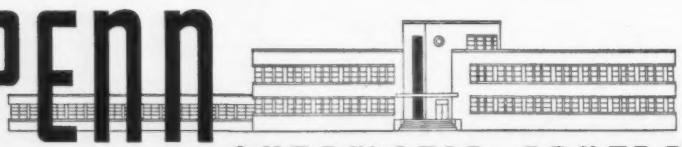

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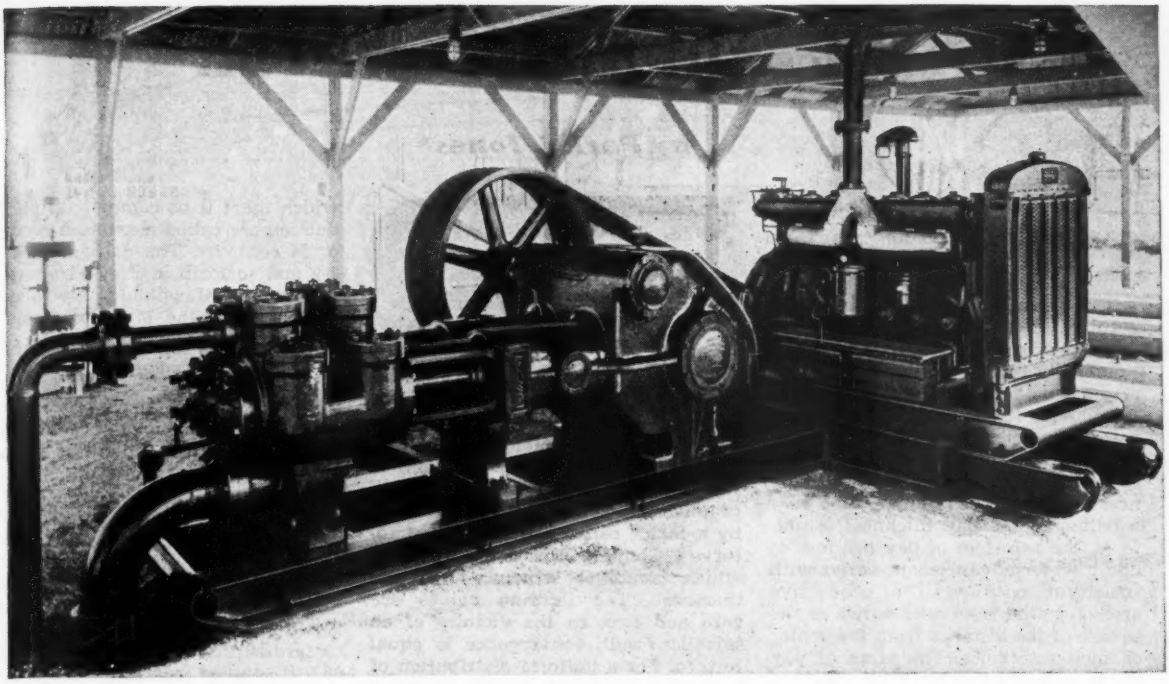
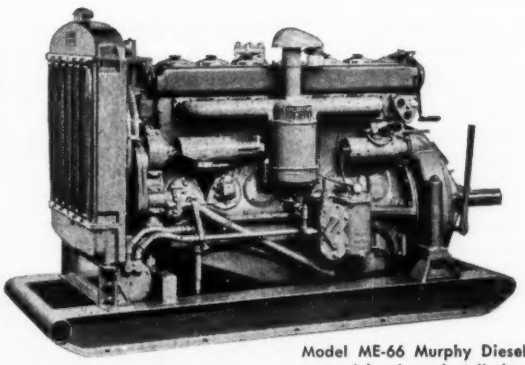


Model ME-66 Murphy Diesel full Diesel engine, 6 x 6½", 6-cylinder, 150 H.P. continuous — 180 H.P. intermittent, powering pipe-line pump, pumping oil at rate of 637 barrels per hour.

Dependable Power for Pipe-Line Pumping

ON long, steady load-pulls, or on heavy, sudden peak-loads, MURPHY DIESEL engines assure dependable power. These rugged engines are right at home on pipe-line pumping jobs, as well as on drilling-rigs, mud pumps, substation and other heavy-duty oil field work. In operation and maintenance costs, they are economical. They are compact, relatively light in weight for heavy-duty service, and easy to move from one location to another. Their flexibility permits adaptation to a wide variety of power requirements. Write for bulletin.



Model ME-66 Murphy Diesel as used in above installation.

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OIL AHEAD OF WATER

*by Park J. Jones**

OIL PRODUCTION by water

PART 3 OF A SERIES

RESERVOIRS have three dimensions and displacement of oil by water is in three dimensions. For production purposes, it is convenient to replace the structural and stratigraphic characteristics of reservoirs by a factor called convergence of reserve. Convergence is a number which combines structure and pay thickness. The limiting values are zero and two. In the vicinity of an injection well, convergence is equal to zero. For a uniform distribution of pay, convergence is equal to unity. Along the crest of a reservoir, convergence is equal to two. The oil displaced ahead of water, aside from expansion, varies with the fluid factor, convergence and the distance advanced by water before reaching producing wells.

Areal Convergence of Reserve

CONSIDER the section shown in Fig. 3-1. If the section were revolved about the vertical axis on the left, the result would be a radial reservoir having a 360° central angle and a uniform pay thickness. The dip is practically flat along the crest but increases in the downdip direction and is about 30 ft. per 1,000 ft. at 0-0, the water contact. Let the curves denote impermeable breaks along the top and bottom of the pay. The pay thickness is uniform and equal to 60 ft.

Although the pay thickness is uniform, the acre-feet of pay per foot of updip water advancement varies with structural position. The productive area on radial reservoirs varies as the square of the distance from the center of such reservoirs. The acres of pay between two contours 1 ft. apart at the distance r is twice the acres of pay between two contours 1 ft. apart at the distance r/2. The length of a contour along a strike is proportional to the average distance to the contour from the center of a radial reservoir. For this reason oil reserve is said to converge areally in the updip direction. Areal convergence of reserve is aside from any variation in pay thickness with structural position.

Convergence and Mapping

Reservoirs have three dimensions: Height, breadth, and length. Displacement of oil by water is in three dimensions. The three dimensions are conveniently combined into one term called convergence of reserve. Convergence for downdip displacement of oil by gas may be entirely different from the convergence for updip displacement of oil by water. This series of articles is limited to displacement of oil by water and it is understood that convergence as here used refers to the updip direction. Convergence is a ratio, a dimensionless number. Convergence is equal to unity if the distribution of acre-feet of pay is uniform.

*Production consultant, Houston.

Radial Convergence of Area

Let water advance updip in the section of Fig. 3-1. The position of the oil-water interface rises progressively to the levels denoted by the solid lines 1-1, 2-2 and so forth. The contours designating these levels on a map are called B contours. Wells completed above a B contour produce dry oil.

Wells completed in the region from which all the recoverable oil has been displaced produce water. The contours designating the levels below which there is no commercial oil production are called maximum recovery or M contours. The dashed lines 1-1, 2-2 and so forth in Fig. 3-1 show the elevation of M contours. The relationship between the M contour and its B contour depends on the convergence of reserve.

If the pay thickness is uniform and the productive area converges radially the relationship between an M contour and its B contour is defined[1] approximately by:

$$M = 1{,}000 + (1{,}000{,}000 + B^2)^{1/2} \quad (1)$$

where B and M are distances in feet from the center of a radial surface.

The M-B curve in Fig. 3-2 is a solution of Equation 1. The distance between M and its B contour on a radial surface is plotted against the distance of a B contour from the center of the radial surface.

The points on top and bottom of pay in Fig. 3-1 were obtained from the M-B curve in Fig. 3-2. The dashed lines were obtained by connecting corresponding M points on top and bottom of pay. This procedure shows a tilt in an M contour as the center of a radial reservoir is approached. (See dashed line 3-3.) However, after water reaches the center, the tilt is likely to be reversed. (See dashed line 4-4.) The reason for the latter is vertical encroachment of water in the center of radial reservoirs.

Radial Displacement Factor

The oil displaced from the region invaded by water along a radial surface varies from about (28 — F) at B up to about (80 — F) at M. The average value within the B-M region, the displacement factor m, is defined by:

$$m = 28 - F + 52\,\frac{B + 2M}{3\,(B + M)} \quad (2)$$

The m curves in Fig. 3-2 are solutions of Equation 2 for fluid factors F equal to 1, 4 and 10. The m curves are in per cent of recoverable oil, that is, m/(80 — F). Equation 2 is derived from Equation 1 by averaging the oil displaced from all points on a radial surface between a given set of B and M contours.

Cumulative Oil Recovery

Oil recovery from the region below an M contour is about (80 — F) per cent of in-place oil aside from structural and stratigraphic trapping of oil and aside from bypassing oil in lenses of comparatively low permeability. For production purposes, it is more convenient to express oil recovery in

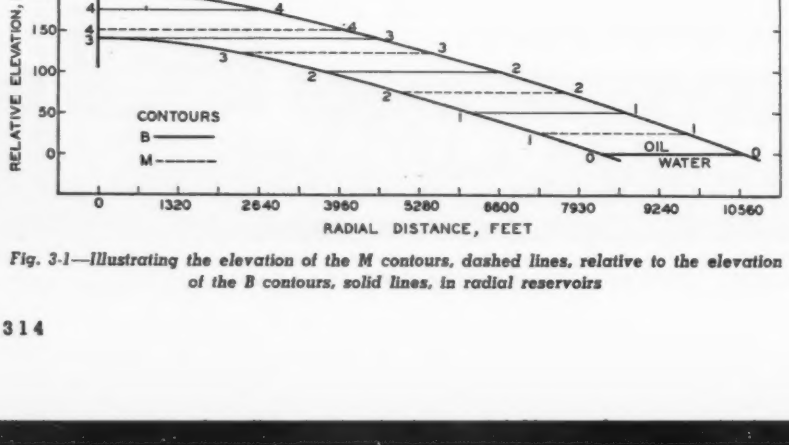


Fig. 3-1—Illustrating the elevation of the M contours, dashed lines, relative to the elevation of the B contours, solid lines, in radial reservoirs

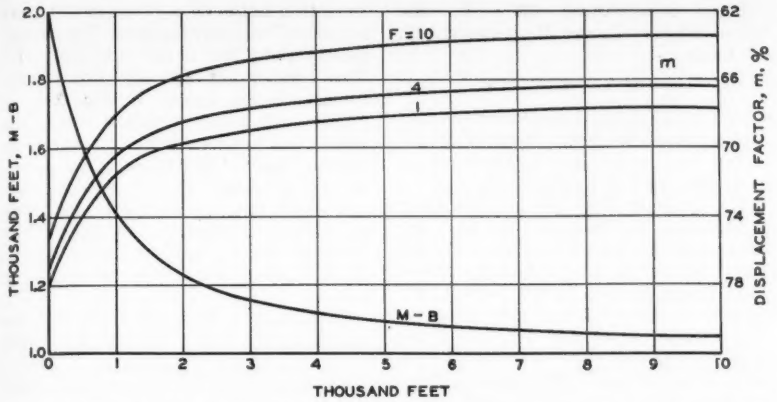


Fig. 3-2—Illustrating the distance between M and B contours along radial surfaces and the displacement factor m in per cent of recoverable oil within a B-M region; F is the fluid factor

per cent of recoverable oil. The recoverable oil is not likely to exceed (80 — F) for most reservoirs. But in reservoirs having abnormal conditions as to permeability, fractures, and solution channels, the recovery from the region completely invaded by water may be less than (80 — F). Relative to recoverable oil, the recovery from the acre-feet of pay below an M contour is (80 — F)/(80 — F) or 100 per cent, that is, the displacement factor is equal to unity in terms of recoverable oil.

The oil displaced from the B-M region on a radial surface for fluid factors on the order of four is approximately two-thirds of the recoverable oil up to about 2,000 ft. from the center of a radial reservoir.

The corresponding cumulative recovery is 100 per cent from the acre-feet below an M contour and two-thirds from the acre-feet invaded by water above an M contour. Production of wet oil from a B-M region decreases the acre-feet of pay within the region, that is, the M contour tends to approach its B contour. The displacement factor for a reduced B-M region is not likely to increase above two-thirds by a significant amount. The principal effect is to increase the acre-feet of pay from which the recovery is 100 per cent of recoverable oil.

As an example, let the recoverable oil be 900 bbl. per acre-foot. Then the cumulative recovery is 900 times the acre-feet below an M contour plus 600 times the acre-feet invaded by water above the M contour. For instance, if the respective acre-feet were equal, the cumulative oil recovery would average (900 + 600)/2 or 750 bbl. per acre-foot invaded by water. If water advances to a level for which the acre-feet of pay in the B-M region is one-third of the total acre-feet, the cumulative oil recovery would be $[\frac{2}{3}(900) + \frac{1}{3}(600)]$ or 800 bbl. per acre-foot invaded by water.

$$C = \frac{2A}{A + a} \qquad (4)$$

where A is the productive area intercepted by a horizontal plane at the elevation M and "a" is the corresponding area at an elevation which is 1,000 ft. updip from M along the top of pay. The symbol C is convergence of reserve. For instance, if a = A within a 1,000-ft. interval along the top of a pay, the convergence is equal to unity.

Displacement Factor for Edge Water

The sketch in Fig. 3-3 will be used to illustrate the derivation of the displacement factor m for a B-M region. Denote the position of an M contour by zero. Let A equal the area enclosed by an M contour. Let B equal

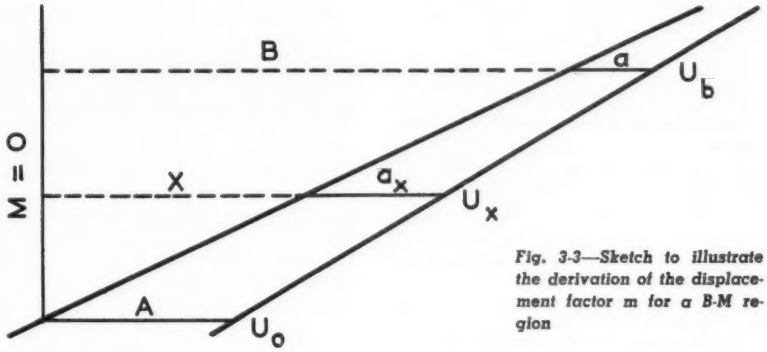


Fig. 3-3—Sketch to illustrate the derivation of the displacement factor m for a B-M region

Convergence for Any Reservoir

In order to be conservative in estimating producing rates and cumulative oil recoveries, the elevation of B and M contours are referred to the top of pay. Let A equal the productive area of a reservoir at any elevation such as M. Let "a" be the productive area at an elevation B which is higher than the M level. Let X equal the distance along the top of pay between the B-M levels. The particular value of X of interest in producing oil by water is defined by:

$$\frac{X(A+a)}{2A} = 1{,}000 \qquad (3)$$

Equation 3 contains two unknowns namely X and "a." To get around this point, let:

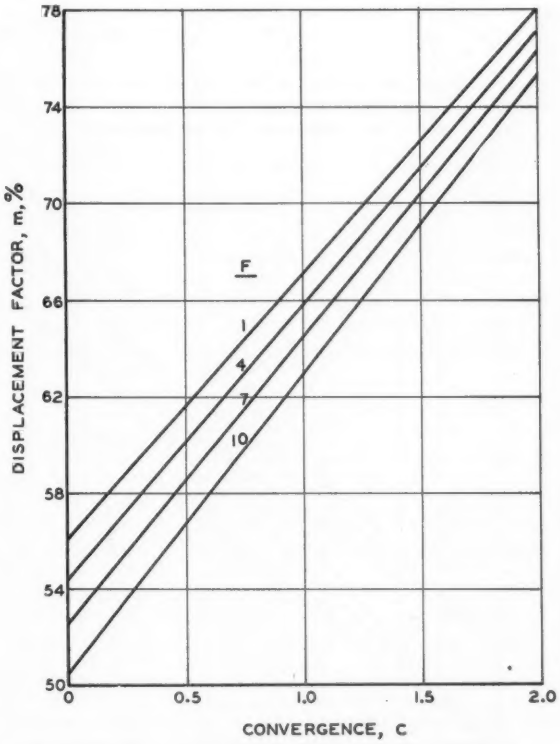


Fig. 3-4—Displacement factor m in per cent of recoverable oil vs. fluid factor F and convergence C within a B-M region

the distance along top of pay from an M contour to its B contour. Let "a" equal the area enclosed by the B contour. The area enclosed by a contour X at any level between M and B is given by:

$$a_x = A - (A - a)\frac{X}{B} \qquad (5)$$

The oil displaced from the area enclosed by an X contour is defined by:

$$U_x = U_o - (U_o - U_b)\frac{X}{B} \qquad (6)$$

where U_o is equal to (80 — F) and U_b, to (28 — F).

The value in the vicinity of the area a_x is proportional to $a_x dX$. The total volume of pay within a B-M region is proportional to B (A + a)/2. Accordingly, the displacement factor m is defined by:

$$m = \frac{\int_0^B U_x a_x dX}{B(A + a)/2} \qquad (7)$$

Integration over the indicated limits gives:

$$m = U_o\left[\frac{2A + a}{3(A + a)}\right] + U_b\left[\frac{A + 2a}{3(A + a)}\right] \qquad (8)$$

But by Equation 4, the area enclosed by the B contour is given approximately by:

$$a = A(2 - C)/C \qquad (9)$$

Substitution of Equation 9 for "a" in Equation 8 gives:

$$m = \frac{1}{6}[U_o(C + 2) + U_b(4 - C)] \qquad (10)$$

Upon substituting (80 — F) and (28 — F) for U_o and U_b respectively, we have:

$$m = 45.3 + 8.7C - F \qquad (11)$$

which is the desired displacement factor expressed in terms of convergence C and the fluid factor F. Equation 11 is in per cent of in-place oil.

The lines in Fig. 3-4 are solutions of Equation 11. However, the data are expressed in terms of recoverable oil. The value of m as defined by Equation 11 was divided by (80 — F). Comparison of the displacement factors in Fig. 3-4 with those in 3-2 will show that the values are identical for a given convergence. The data in Fig. 3-4 may be applied to injected water and encroaching edge water but not to bottom water.

Development of B-M Regions

The distance along the top of pay between a given set of B-M contours is about 1,000 C ft. However, an M contour does not begin to advance until the B contour advances about 1,000 C ft. The displacement factor for the acre-feet invaded by water increases progressively until the M contour starts advancing. The lines in Fig. 3-5 give the displacement factors for a developing B-M region. The solid lines are for a fluid factor equal to unity. The dashed lines are for a fluid factor equal to 10. The variation between a given set of lines is caused by convergence. The initial point on any line is (28 — F)/(80 — F). The final point on any line corresponds to the values in Fig. 3-4.

The maximum efficient rate, the MER, for producing oil by water is on the order of 200 ft. per year parallel to bedding.[2] The B contour advances at the rate of 200 ft. per year in reservoirs produced at MER. The time in years required to develop a B-M region completely is equal to about 5 C.

The lines in Fig. 3-6 show how the displacement factor varies with time for a developing B-M region. After a B-M region is developed, the displacement factor does not vary with time. However, a change in the properties of fluids, or in the convergence of reserve, would cause some variation of the displacement factor for a B-M region.

Summing up, the cumulative oil recovery by injected, or encroaching edge, water is equal to the acre-feet within a B-M region times the recoverable oil per acre-foot times the displacement factor for the B-M region plus the acre-feet below an M contour times the recoverable oil per acre-foot.

References

1. The Oil and Gas Journal, Oct. 20, 1945, p. 147.
2. Ibid, Sept. 15, p. 81.

Fig. 3-5—Displacement factor in per cent of recoverable oil vs. the relative position of an oil-water interface in a developing B-M region; C is convergence; F is the fluid factor

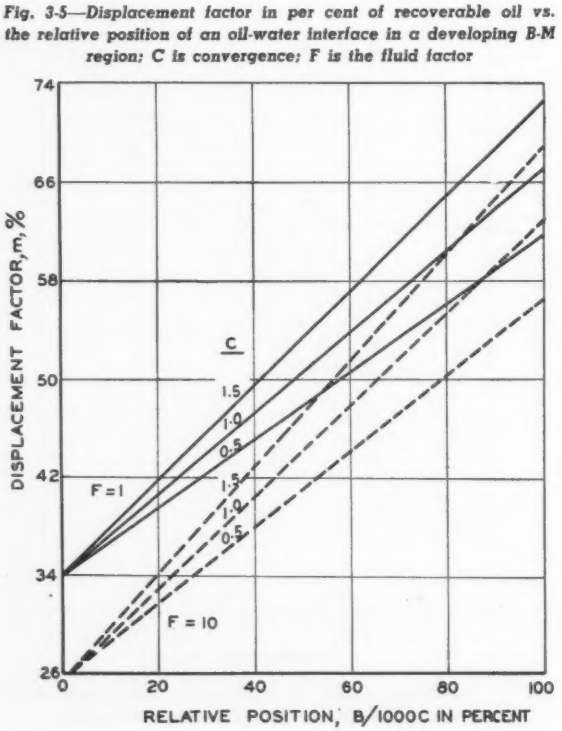
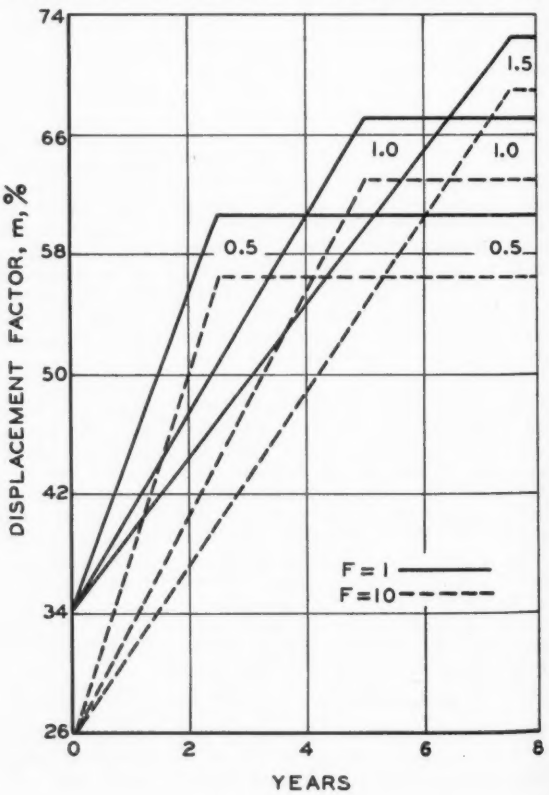


Fig. 3-6—Displacement factor in per cent of recoverable oil vs. the number of years required to develop a B-M region at MER for convergence equal to 0.5, 1.0 or 1.5 and fluid factor equal to 1 or 10



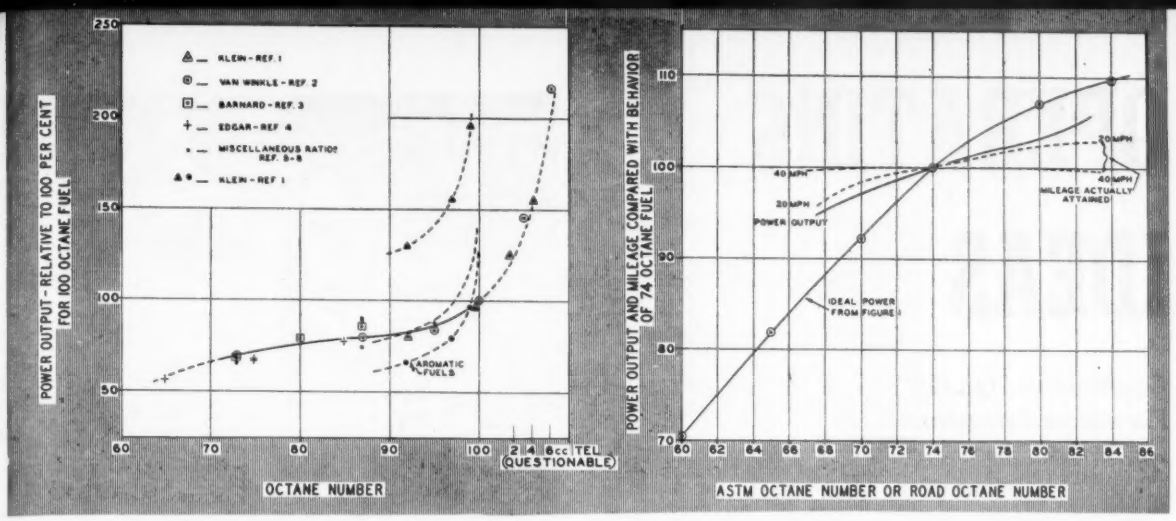

POWER OUTPUT - RELATIVE TO 100 PER CENT FOR 100 OCTANE FUEL
KLEIN - REF. 1
VAN WINKLE - REF. 2
BARNARD - REF. 3
EDGAR - REF. 4
MISCELLANEOUS RATIOS REF. 5-8
KLEIN - REF. 1
AROMATIC FUELS
OCTANE NUMBER
4cc TEL QUESTIONABLE
POWER OUTPUT AND MILEAGE COMPARED WITH BEHAVIOR OF 74 OCTANE FUEL
40 MPH
20 MPH POWER OUTPUT
IDEAL POWER FROM FIGURE 1
20 MPH
40 MPH MILEAGE ACTUALLY ATTAINED
ASTM OCTANE NUMBER OR ROAD OCTANE NUMBER

Fig. 1—(Left) Approximate power output of gasoline engines, each operating on the octane-number fuel best suited to its needs. Power output is shown relative to power output of a 100-octane fuel in a 100-octane engine. Fig. 2—(Right) Relative mileage and power output of commercial vehicles as a function of octane number required by each vehicle. Values relative to a 74-octane vehicle. (Reference 9)

QUESTIONS on TECHNOLOGY

by W. L. Nelson
Consulting Engineer

Power vs. Octane Number

Why don't we get larger mileages with high-octane-number fuels? What is the power output of various fuels? —A.P.R.

Octane number is not directly related to the power output of the engine in which it is employed. There is a particular octane-number fuel required by each engine at its own peculiar state of mechanical adjustment. Octane numbers higher than that required to keep such an engine from knocking do not allow more development of power or greater mileage. Thus, if an engine requires a fuel of 70-octane number to keep from knocking, it develops little or no more power if an 80-octane fuel is used.

The full meaning of the above statements is that each time a higher-octane fuel is purchased it is necessary to readjust the engine so that it can utilize the higher octane fuel, or in most instances purchase a new engine for the better fuel. Until suitable engines are provided, the larger power output of high-octane fuels will not be readily apparent.

In an attempt to clarify the situation, Fig. 1 was assembled from readily available references. None of these references presents the particular values shown in the figure but the data of each experimentor were compared on a common basis of 100 (units) power output for a 100-octane (A.S.T.M.) fuel. Data on fuels which contained tetraethyl lead to make octane numbers in excess of 100 were plotted on a purely arbitrary scale which has no real relation or position with respect to the behavior of nonleaded fuels having octane numbers less than 100.

Fig. 1 applies only to the power output of a series of engines, a different engine for each octane number. Thus it cannot be applied to the behavior of a single engine operating on a number of fuels. In large part the data for Fig. 1 apply to aircraft engines which were developed in each case for a particular octane number fuel. There is no assurance, however, that perfection has been attained with each engine and hence as more and more experimental data become available it may be found that the curve will become steeper (or less steep).

Only one set of data fails to fall in line. It gives the results of Klein (Reference 1) in comparing aromatic gasolines with isoparaffin blends. The points (large solid ones) may be misleading because they infer that the power output of 92 and 97-octane aromatic fuels is less than for paraffinic ones of the same octane number. In reality such fuels under most operating conditions produce more power than paraffinic fuels and had we used 92 octane as the comparison point (common to all tests) the aromatic points would have been located on the average line at 92 and extended upward above the line at a value of 100 octane. Finally, Klein's data indicate that aromatic fuels produce the large amount of power shown by the curve with solid triangular points.

The power output of a single engine when operating with different octane-number fuels, is not by any means clear. In addition to difficulties with adjustment, makes of cars, effect of speed, carbon in engines, etc., the situation is further confused by the use of so-called road octane numbers. However, the studies of Hartesveldt and Field (Reference 9) are probably representative and dependable and hence their data are shown in Fig. 2. It should be noted that even the small differences evident in Fig. 2 cannot be attained without some conscious adjustment by the operator of the vehicle. When no adjustment is made for each different speed and condition, a high-octane fuel may be no better or may even produce less power than a low-octane fuel. Mileage is the real measure of performance (dotted lines on Fig. 2, at 20 m.p.h. and two-thirds throttle and at 40 m.p.h. on level road). The solid lines are power output from Reference 9 and Fig. 1 for comparison.

In summary, it appears that theoretically we can develop more power from high-octane fuels, as indicated in Fig. 1, by building better engines and utilizing them completely by not varying the operating conditions, but the mileage of commercial vehicles is little changed by octane number.

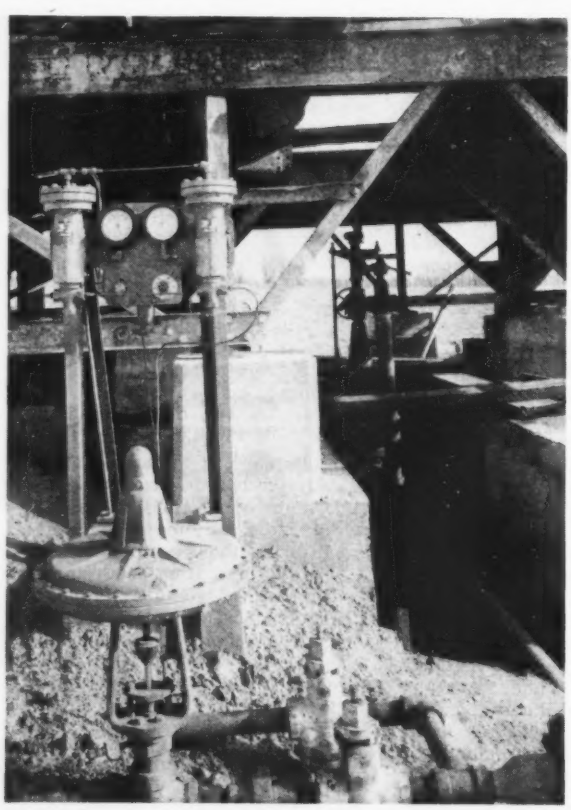
References

1. Klein, F. D., Future Possibilities of 100-Octane Aircraft Engine Fuel, Jour. S.A.E. 39, pg. 304, 1936.
2. Van Winkle, M., Aviation Gasoline Manufacturing, McGraw-Hill Book Co., Inc., N. Y., 1944.
3. Barnard, D. P., Value of Octane Numbers In Flying, Jour. S.A.E. 41, pg. 415, 1937.
4. Edgar, G., The Automotive Engine and Its Fuel, Jour. S.A.E. 31, pg. 461, 1932.
5. Bass, E. L., Aircraft Engineering, Vol. 6, pg. 320, 1934.
6. Klein, F. D., Journal Aeronautical Science, Vol. 2, pg. 43, 1935.
7. Dubois & Cronstedt, High Output in Aircraft Engines, Jour. S.A.E. 40, pg. 225, 1937.
8. Heron, S. D., Aircraft Operation with Fuels of 100 Octane and Higher, Petroleum Refiner 16 (11) 521.
9. Van Hartesveldt & Field, Knocking Octanes, Petroleum Refiner, June 1940, pg. 93.

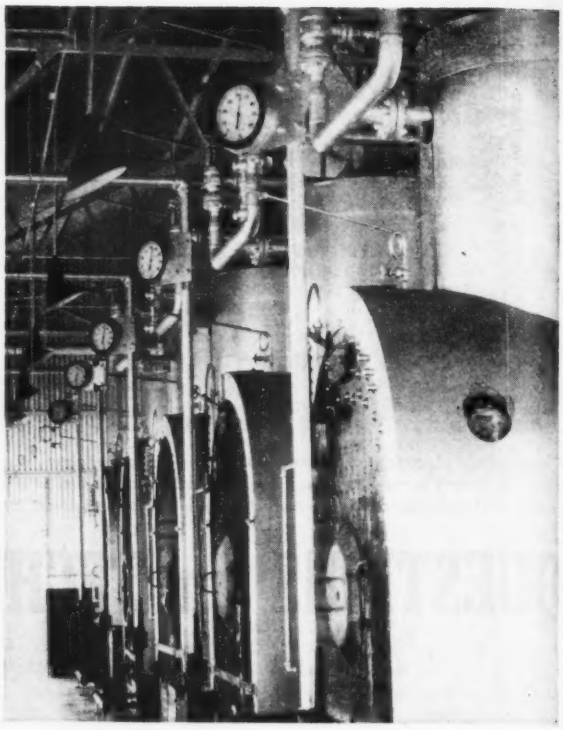
OPERATING IDEAS

Continuous "On-Off" Flow-Line Protection

THIS "automatic watchman" on a newly completed well closes off the flow line whenever the pressure rises above 700 psi. or drops below 200 psi. Purpose is to afford protection to lease equipment and prevent hazards which might accidentally arise. If the separator should "block," hydrates form, or other stoppage occur when preset high-pressure limit is reached, the left-hand pilot control admits pressure to under side of the case of the main motor-diaphragm valve, and the well shuts off. In the other direction, should a break occur in the flow



line or some portion of the separation system be inadvertently opened, the right-hand pilot control similarly shuts off the main valve when the pressure decreases below the preset minimum condition. This particular producer is a "combination" well. Located in Oklahoma County, Oklahoma, it is equipped with a high-pressure separator, from which the gas is sold to a natural-gas utility pipe line. A very small quantity of gas from the separator is the operating medium that actuates the maximum-minimum safety control setup.

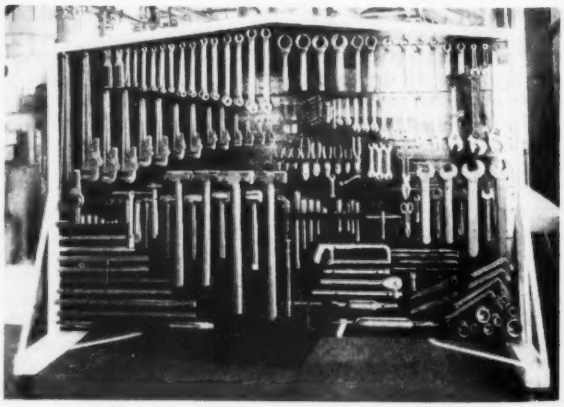


Pressure Gages Installed at Angle

BOILER-ROOM steam-pressure gages are installed at a 45° angle so that the operator can read the pressure on all five gages without passing down the line to each individual boiler. This is effected by attaching special plates, which are fastened to the fuel lines with U-bolts and allowing any angle desired. The installation was worked out by the plant superintendent when the boilers were installed. Commonly, such gages are attached and aligned with the boiler, in which case the operator must be directly in front of any one to read it.

Handy Tool Rack

THIS tool rack holds a complete assembly of tools used in the maintenance of 800-hp. compressor engines in gas booster stations. Face of the board contains hand tools and grease guns. The back of the board has compartments for fittings, packing, and gaskets. Although this board is quite heavy, two men can move it to any location inside the engine room when repairs are needed. It is situated in the Canadian River Gas Co. booster station at Dalhart, Tex.



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TRADE MARK

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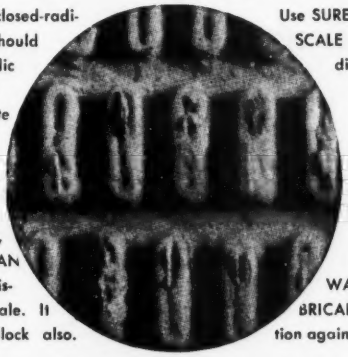
"SURE KLEAN" SCALE SOLVENT

All engine closed-radiator systems should have a periodic SURE KLEAN treatment. Note cut. Maintenance service would have prevented this condition, as SURE KLEAN NO. 1 will dissolve this scale. It cleans the block also.



Use SURE KLEAN NO. 1 SCALE SOLVENT for dissolving scale from radiator and block, SURE KLEAN NO. 3 RUST INHIBITOR SOLUBLE OIL WATER PUMP LUBRICANT as a prevention against reoccurrence

A scale-clogged radiator, as illustrated, is caused not by scale formed thereon but by scale broken loose from block of motor. Use SURE KLEAN NO. 1. It cleans the water jacket and radiator.

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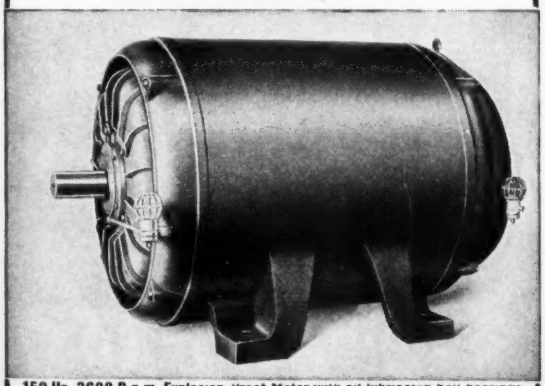

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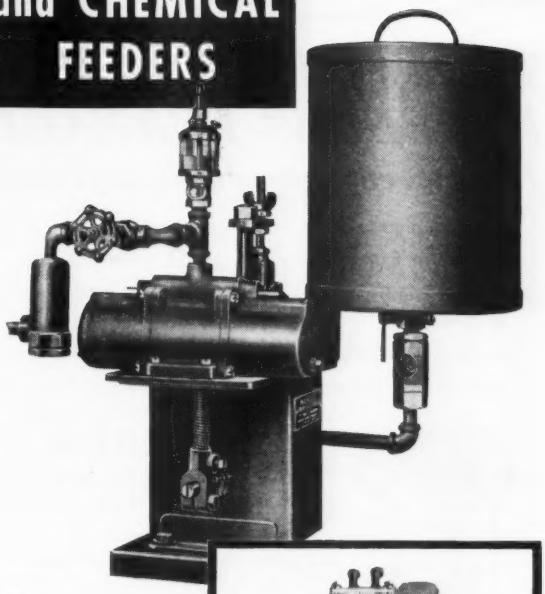

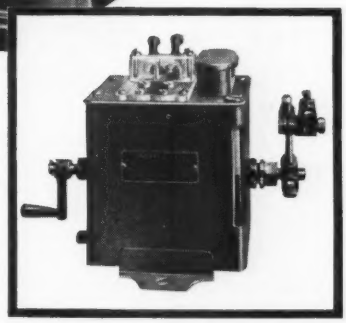

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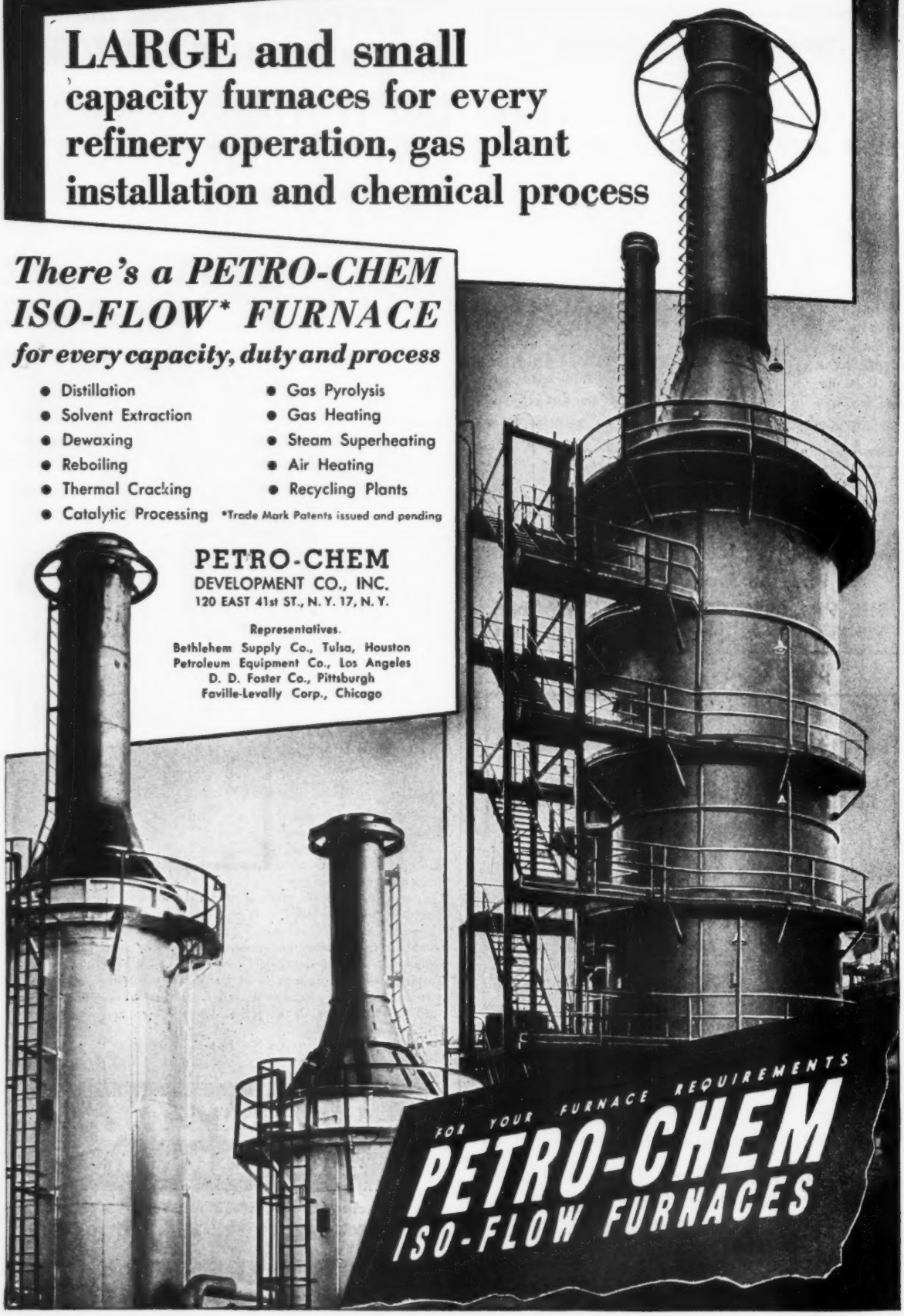
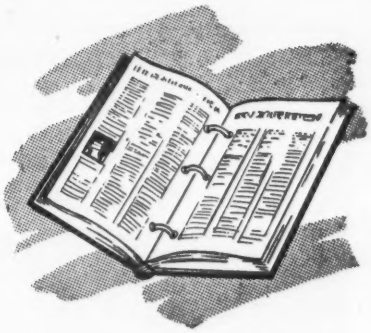
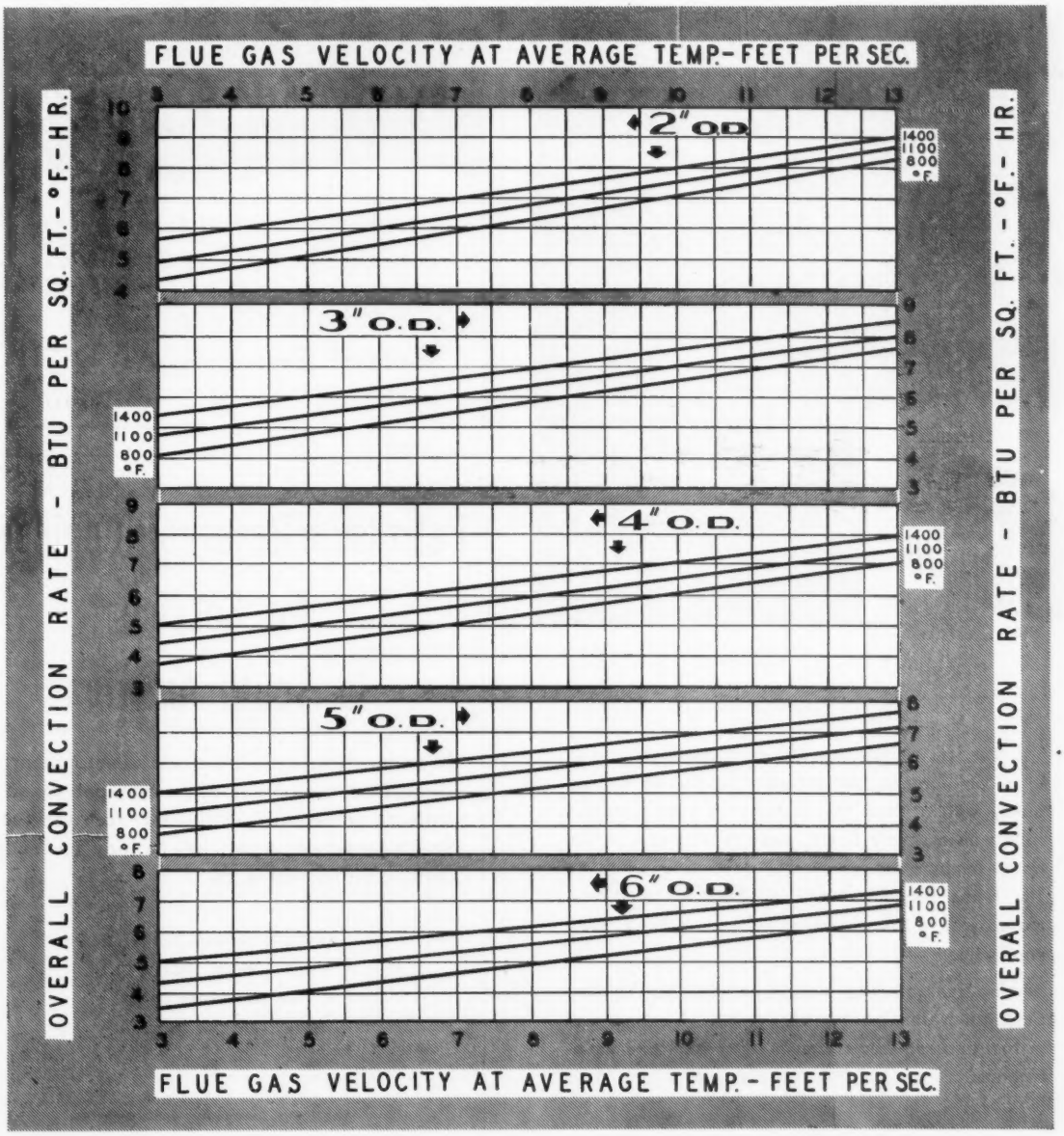


The Refiner's Notebook

A WEEKLY FEATURE OF THE OIL AND GAS JOURNAL



Convection Transfer Rates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3" O.D.
4" O.D.
5" O.D.
6" O.D.
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1100
800
°F.
3 4 5 6 7 8 9 10 11 12 13
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No. 119 in a series by W. L. Nelson, professor of petroleum refinery engineering, University of Tulsa

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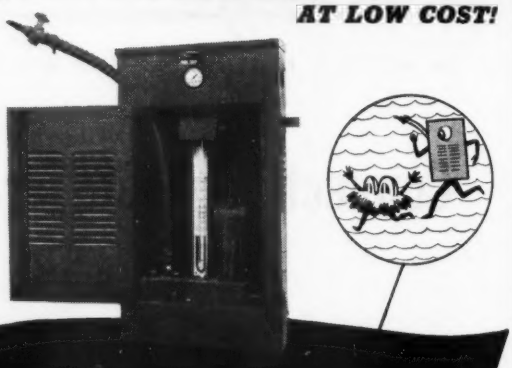

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A FEATURE OF THE OIL AND GAS JOURNAL

Lime-Soda Water Softening—The Precipitates

IN the application of lime-soda softening to a given water supply, if the hardness content of that water is chiefly in the carbonate form, which requires lime for its precipitation, a reduction in solids content will be effected. If, on the other hand, the hardness content of the water is chiefly in the noncarbonate form a marked reduction in the solids content of this supply through lime-soda softening is unlikely.

It will be noted that two different forms of precipitates are produced in the lime-soda process. These are calcium carbonate—$CaCO_3$—and magnesium hydroxide—$Mg(OH)_2$. In contrast with the crystalline nature of calcium carbonate, magnesium hydroxide is gelatinous in character and may serve as a coagulating agent aiding the settling of these precipitates in the sedimentation tank. Magnesium oxide is frequently employed as a coagulant in both hot and cold process lime-soda softening. In addition the magnesium hydroxide precipitate formed through the use of this coagulant or formed from the precipitation of magnesium naturally present in the raw supply possesses the property of adsorbing soluble silica from solution, thereby effecting its removal.

Use of Caustic Soda

Under some circumstances, caustic soda (sodium hydroxide) can be substituted in place of lime and soda ash if the carbonate and noncarbonate hardness of the raw water are in the correct proportions. The reaction of caustic soda with calcium bicarbonate hardness is illustrated below:

$$\underset{\text{calcium bicarbonate}}{Ca(HCO_3)_2} + \underset{\text{sodium hydroxide}}{2NaOH} \quad (1)$$

$$= \underset{\text{calcium carbonate}}{CaCO_3} + \underset{\text{sodium carbonate}}{Na_2CO_3} + \underset{\text{water}}{2H_2O}$$

Soda ash (sodium carbonate) is produced as a by-product in this reaction which becomes available for the precipitation of calcium non-carbonate hardness as shown by Equations 6 and 7 in the previous issue (November 9, Installment No. 259). The use of caustic soda for softening is rather limited because of the necessity for a definite relationship between the carbonate and noncarbonate hardness in the raw water and the lack of flexibility in caustic soda treatment if the raw water is subject to material fluctuations.

Use of Gypsum (Calcium Sulfate)

Highly alkaline waters containing appreciable quantities of sodium bicarbonate—$NaHCO_3$—are characteristic of certain sections of the country. This type of water possesses a total alkalinity considerably greater than the total hardness. To condition this type of water (particularly for boiler makeup) lime and gypsum are employed. These waters do not require the use of soda ash. Lime reacts to precipitate the carbonate hardness as in Equations 2 and 3 of Installment No. 259. In the presence of sodium bicarbonate, lime reacts to precipitate calcium carbonate and to form sodium carbonate as shown:

$$\underset{\text{sodium bicarbonate}}{2NaHCO_3} + \underset{\text{calcium hydroxide}}{Ca(OH)_2} \quad (2)$$

$$= \underset{\text{calcium carbonate}}{CaCO_3} + \underset{\text{sodium carbonate}}{Na_2CO_3} + \underset{\text{water}}{2H_2O}$$

For the removal of the sodium carbonate thus formed, gypsum (calcium sulfate) is employed to precipitate calcium carbonate as follows:

$$\underset{\text{sodium carbonate}}{Na_2CO_3} + \underset{\text{calcium sulfate}}{CaSO_4} \quad (3)$$

$$= \underset{\text{calcium carbonate}}{CaCO_3} + \underset{\text{sodium sulfate}}{Na_2SO_4}$$

It will be noted that the use of gypsum for the removal of sodium bicarbonate does not decrease the solids content of the water but instead replaces the sodium bicarbonate with an equivalent amount of sodium sulfate. In most cases this sodium sulfate is less objectionable than the sodium bicarbonate.

The chemical precipitating reactions are considered to be instantaneous. This fact is not evident in the practical operation of softeners because all of the insoluble reaction products (sludge) are not immediately precipitated in a form permitting rapid and efficient sedimentation or separation from the water. A portion of the sludge formed is comprised of relatively large flocs or crystals, readily separated by sedimentation. The remainder of the sludge will be of smaller particle size and will not readily settle. Some of these particles are present as colloids and are difficult to separate from the water. It is necessary to coagulate these smaller particles into agglomerates capable of producing a sludge of required characteristics.

If a sufficient amount of magnesium is naturally present in the raw water, in most cases satisfactory coagulation results because of the coagulating properties of the magnesium hydroxide precipitated in the softening process. In the absence of sufficient natural coagulation, recirculation of softener sludge or the addition of coagulants such as magnesium oxide (Remosil), sodium aluminate, or ferric sulfate (Ferrisul) should be employed.

Temperature is an important factor directly affecting the rate of sedimentation which is in turn governed by the density of the water and the time required to effect optimum particle size. At higher temperatures, the density of the water is less and more rapid settling of the sludge is permitted in the absence of convection currents.

Recirculation of sludge provides a contact medium for proper precipitation. Recent developments of cold process softening take advantage of chemical laws governing precipitation from a supersaturated solution. The use of lime and soda ash in the cold results in the formation of a supersaturated solution, or, in other words, the water contains more calcium carbonate in solution than would normally be dissolved in that water at a given temperature. If, however, particles of calcium carbonate sludge are brought into contact with water supersaturated with calcium carbonate, crystallization of calcium carbonate from solution will occur on these particles and thus the water is desaturated.

This material is from the Betz Handbook for Industrial Water Conditioning, written and published by W. H. and L. D. Betz, consulting engineers, Philadelphia.

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REFINING

Continental to Double Size of Denver Plant

PONCA CITY, Okla.—Plans for a $4,000,000 construction program for enlargement of Continental Oil Co.'s Denver refinery to twice its present size have been announced at the company's general offices here.

The project will include erection of catalytic-cracking and polymerization units of the type used during the war for the manufacture of 100-octane gasoline.

Completion of the project, which is scheduled for early 1948, will boost the crude-oil charging capacity of Continental's Denver refinery to approximately 7,500 bbl. daily. Construction work will start in the early spring of 1947, and about 300 men will be required in building the new units, the announcement stated.

"Continental Oil Co.'s increased crude-oil production in the Rocky Mountain area, coupled with the growing demand for our products, has made this project essential," the announcement said. "All of the crude oil processed in this plant will be from Continental's own oil wells in the Rocky Mountain area, mainly from the Lance Creek and Rangely fields, and will flow into the Denver refinery through the lines of Rocky Mountain Pipe Line Co., which are owned in large part by Continental."

Continental's Denver refinery was built in 1930, and was enlarged in 1936. The new construction program will not only double the size of the plant but will completely modernize it, utilizing the very latest equipment developed during and since the war.

Asphalt Roofing Production Now Twice That of 1939

WASHINGTON. — Annual production of asphalt shingles and roll roofing has virtually doubled since 1939, according to the Department of Commerce. Asphalt products now comprise 89 per cent of all roofing material manufactured, the department reported. Output of asphalt roofing material is at the rate of about 75,000,000 squares yearly, an increase of 39 per cent over the wartime peak of 54,000,000 in 1942.

New housing and replacements will require 73,735,000 squares this year and 80,474,000 in 1947, the Department of Commerce estimates. A square of shingles will cover 100 sq. ft., and the roof of the average house requires 12 to 15 squares.

The current high production levels have been attained, industry officials say, by improvements in manufacturing processes, with little increase in prewar plant capacity. Recently constructed plants have not yet reached capacity production.

Scientists Needed to Develop New Products, Says Russell

NEW YORK.—Thousands of young scientists and engineers are needed to help in the task of developing still more products from petroleum, R. F. Russell, president of Standard Oil Development Co., declared in a broadcast sponsored by the Chamber of Commerce of the United States as part of its "Voice of Business" program. He predicted a bright future in the refining and other branches of the oil industry and told of his company's plans for stimulating scientific education. Russell's statement was made in connection with an "Oil the Magic Molecule" feature, which saluted the oil industry for its ingenuity and progressiveness in making an increasing number of new products available.

Russell, who directs the principal research and technical organization of Standard Oil Co. (N. J.), revealed that his company's research staff had grown from 458 men and women in 1936 to 1,900 today. Further increases are expected when necessary facilities and personnel are available, he added. His company hoped to stimulate scientific education by setting up additional scholarships and by increasing research grants to universities.

Estimating that the war interrupted the education of about 150,000 engineering and science students, the speaker said it would be several years before the shortage of scientists could be overcome even though universities were stretching their capacities and taxing their facilities to the utmost to meet the demand.

Credit for America's world leadership in oil was attributed chiefly to teamwork between science and industry and the competition in a free market by dozens of major oil companies and more than 3,000 smaller ones.

Study of German Products And Processes Advised

WASHINGTON. — The American chemicals industry is advised by John C. Green, director of the Office of Technical Services, Department of Commerce, to send more experts to Germany to investigate products and processes not yet fully studied. Among chemicals and processes believed to warrant further examination are chemicals from the Fischer-Tropsch synthesis, chlorination of methane, ethane cracking, catalysts, and synthetic bodies for modification of surface coatings, as well as liquid fuels and lubricants.

Green pointed out that signing of a peace treaty and the return to more normal conditions in Germany will probably result in German industry being closed eventually to American investigation. He urged that American firms play safe and complete necessary studies within the next 6 months.

If industry is to gain the maximum profit from the opportunity to utilize German scientific developments, specific studies must be made of many chemicals and processes, drawings, formulas, and documents. Years of research and millions of dollars may be saved by utilizing German developments, Green said. As an example, greatly increased concentrations of caustic soda may be obtained with the mercury-type chlorine cells used by I. G. Farben.

Rubber Plant to Close

LOUISVILLE, Ky. — B. F. Goodrich Co.'s GR-S synthetic rubber plant here will be closed December 31, the company has announced. Another Goodrich plant here, producing geon synthetic rubber, wil continue in production and is expected to be extended during 1947. The present GR-S plant will eventually be converted for the production of geon.

Taylor and Coastal May Change Hands

NEW YORK.—Negotiations are under way between Petroleum Heat & Power Co. here and Taylor Refining Co., looking to purchase of the latter by Petroleum Heat, which thus would become an integrated organization.

If approved by the stockholders, Petroleum Heat would acquire all the Taylor stock and indirectly have an interest in Coastal Refineries, Inc., as Taylor owns a stock interest in Coastal.

Taylor Refining, with headquarters in Taylor, Tex., has a 30,000-bbl. daily refinery at Corpus Christi. Coastal, with headquarters at San Antonio, has a 10,000-12,000-bbl. daily refinery at Port Isabel, Tex. Combined crude-oil production owned by these companies is about 16,000 bbl. daily, with Taylor controlling the major share, or about 1,200 bbl.

Both Taylor and Coastal control gas production which is now being sold to a gas company. Around the first of the year it is expected that a contract will be signed whereby more gas will be sold. Whether a recycling plant will be built by Petroleum Heat, if it acquires the Taylor interests, has not yet been decided.

Petroleum Heat has been a marketing concern along the East Coast and in the Chicago area for the past 31 years, and it has a large business in oil-burner sales. It is 50 per cent owned by Pan American Petroleum & Transport Co., which, in turn, is a subsidiary of Standard Oil Co. of Indiana.

Monsanto to Buy Plant

ST. LOUIS. — Monsanto Chemical Co. will buy the Texas City, Tex., styrene plant from War Assets Administration, according to an announcement by Edgar M. Queeny, Monsanto board chairman. The $10,000,000 to be paid for the plant will be provided by a 25-year bond issue.

Acid Plant for Sale

WASHINGTON.—A complete sulfuric acid concentrating unit, a part of the East Tennessee Ordnance Works, Copperhill, Tenn., has been offered for sale by the War Assets Administration. WAA is requiring the purchaser to agree to remove the unit from the site.

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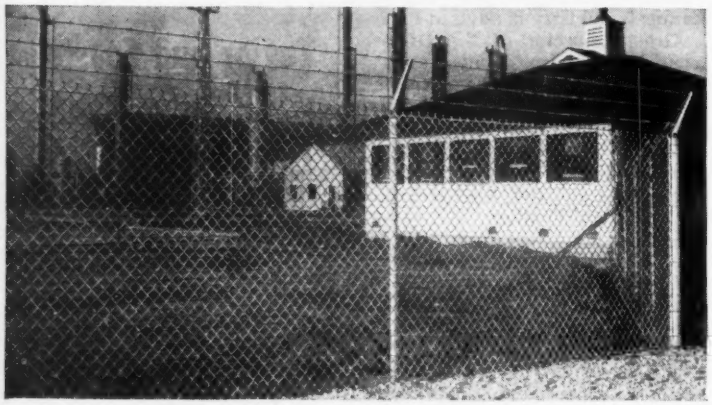

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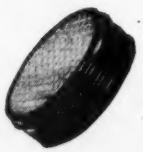

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PIPE LINES

Stanolind Asks for Bids On 119 Miles of 20-In.

Stanolind Pipe Line Co. issued specifications on November 6 and asked for bids from contractors to be submitted December 3 for construction of six loops of 20-in. pipe. The entire project totals 119 miles. These loops will be laid in sections located between pump stations at points on the trunk system as follows: Drumright - Hominy, Okla., 20.61 miles; Hominy - Blake, Okla., 14.2 miles; Blake, Okla.,-Sycamore, Kans., 11.6 miles; Sycamore-Humboldt, Kans., 21.14 miles; Humboldt-Centerville, Kans., 21.14 miles; Centerville, Kans.-Freeman, Mo., 23.08 miles. These loops are to be bid as three separate jobs. Work is to start January 1.

The 20-in. pipe for the loops is to be coated and wrapped throughout with Perolite coating and asbestos felt.

This is the first step in the large pipe-line expansion program of Stanolind Pipe Line Co. described on page 158 of this issue.

Interstate Extends System To Serve Louisiana Pools

Interstate Oil Pipe Line Co. is laying 5 miles of 4-in. from Catahoula Lake to the Catahoula-Cypress Bayou area to Nebo pool, Louisiana, to connect with Placid Oil Co. facilities. This line will move Cypress Bayou crude oil formerly transported by tank car. Construction, started late in October, was scheduled for completion November 15. The contractor, Associated Contractors & Engineers, will lay approximately 6 miles of 4-in. which will extend Interstate's Bayou Sale trunk line into the Bayou Carlin field in St. Mary's Parish of Coastal Louisiana.

In connection with these projects applications have been filed with the engineers' office of the War Department for permits for crossings at Catahoula Lake and French Fork.

Hope Natural Gas Submits Second Expansion Program

WASHINGTON.—Hope Natural Gas Co. has filed another application with the Federal Power Commission, its second in recent weeks, asking permission to construct additional facilities in West Virginia at a cost of $4,700,000.

Facilities requested in the new application will enable Hope Natural to receive larger supplies of gas from Tennessee Gas & Transmission Co.

Construction plans for 1947 include addition of four 1,000-hp. compressor units to Cornwell station, about 45 miles of 12-in. loop line extending from Hastings station to a point in Gilmer County, and a booster station in Doddridge County. During 1948 three more 1,000-hp. compressor units would be added to the Cornwell station and three 2,000-hp. compressor units, six high-pressure gas compressors, piping changes, and coolers to Hastings station. The company also plans to construct about 14 miles of 12-in. loop line paralleling an existing line starting at Jones station.

Hope's earlier application filed with FPC late last month proposed installation of additional compressor capacity in five existing stations as well as construction of loop lines. Cost of

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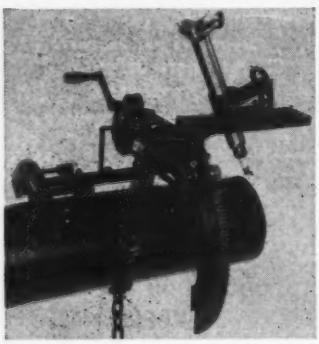

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this program was estimated at $4,600,000.

The proposed facilities would bring into the company's system additional supplies of gas from production in Wyoming County, West Virginia. These increased supplies would be used to meet customers demands, particularly those of the Manufacturers Light & Heat Co., Pittsburgh, which Hope has agreed to supply with substantially larger volumes of natural gas for a 10-year period.

The construction proposed includes installation of 2,400-hp. compressor capacity at the Oscar Nelson station in Wyoming County, 1,600-hp. compressor capacity at the Loup Creek station in Wyoming County, 2,400-hp. at Jones compressor station in Gilmer County, and 4,000 hp.-compressor capacity in Hastings compressor station in Wetzel County, together with a new boiler of 125,000 lb. per hour capacity. Loop lines proposed consist of about 58 miles of 20-in.

Construction of 832 Miles Planned by Tennessee

HOUSTON. — Tennessee Gas & Transmission Co. has applied to Federal Power Commission for permission to increase the capacity of its natural-gas pipe line by an additional 219,000,000 cu. ft. daily. Half of this is expected to be provided by utilization of flare gas now being wasted along the Gulf Coast.

The natural-gas line from South Texas to West Virginia now has an authorized capacity of 381,000,000 cu. ft. daily and the additional looping of the line will raise the delivery capacity to approximately 600,000,000 cu. ft. Cost of the expansion is estimated at $59,545,000.

The line is now taking or has commitments to take 105,000,000 cu. ft. of flare gas daily and the company is negotiating for an additional 115,000,000 to fill half the increased capacity if the application is approved by FPC. The project will be a second major step by Tennessee Gas & Transmission Co. toward conservation of gas and will move a product previously wasted into useful channels. President Gardiner Symonds said.

To accomplish the increase in delivery capacity, Tennessee has asked permission to construct one new compressor station in Nueces County, Texas; install in existing compressor stations new compressor units totaling 81,600 hp.; and to construct 681.1 miles of 26-in. loop, 68.7 miles of 24-in. loop, and 82.4 miles of 20-in. loop along the company's 1,265-mile, 24-in. line. Plans are also made to lay various gathering lines to connect the main line with the source of gas.

Tennessee hopes to begin work on the project in the summer of 1947. The application sets out that there is an unprecedented demand for natural gas for residential consumption in the Appalachian area it serves, and that the company has firm contracts for the sale of approximately 600,000,000 cu. ft. of gas on peak days. The company estimated that the new contracts will permit operation of its system on an annual basis of about 85 per cent of its designed delivery capacity.

Interstate Installs Electric Units at Roff Station

Installation of two electric pumping units at Interstate Oil Pipe Line Co.'s Roff booster station, near Ada, Okla., has boosted the capacity of

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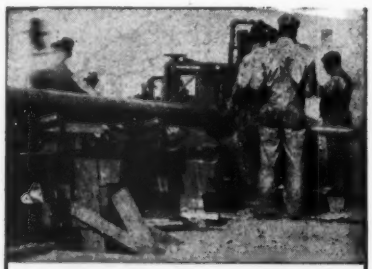

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*Patent pending.

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the Cromwell-Hewitt line from 23,000 to 30,000 bbl. per day.

Installation of the larger pumping units, which were taken from Interstate's Council Hill station on the Glenn Pool-DeQueen line, was accomplished without interruption of service.

Jersey Standard Pipe-Line Group Attends Conference

Interstate Oil Pipe Line Co. was host to 25 engineers and accountants from various pipe-line companies affiliated with the Standard Oil Co. (N. J.) who were attending a technical committee conference in Tulsa November 4 and 5.

The conference was called to make plans for a program of technical development and betterment of pipeline operations over a period of years.

Operations Start on Texas-California Line

Clearing of right-of-way started last week for building the California section of the Texas-California natural-gas pipe line. Initial work was begun 12 miles west of Blythe, Calif., by bulldozer equipment of H. C. Price Co., contractor for Southern California Gas Co. and Southern Counties Gas Co. Stringing of 30-in. pipe has begun. Laying operations are scheduled to start after the first of the year.

Magnolia Tex.-Ill. 20-In.

Magnolia Pipe Line Co.'s 20-in. crude-oil pipe line to be built in 1947 from Corsicana, Tex., to Patoka, Ill., is described on page 158 of this issue.

Pipe-Line Tax Receipts Up

WASHINGTON.—Receipts in September from the federal tax on pipeline transportation rose slightly over previous month to a total of $1,197,610, according to figures released by the Bureau of Internal Revenue. August collections totaled $1,168,799; September 1945 collections were $1,201,229.

Aerial Survey Completed

MIDLAND, Tex. — Aerial photographs and abstract land ownership information for Phillips Petroleum Co.'s projected 365-mile products line from Phillips, Tex., to Denver, have been completed by Kargl Aerial Surveys, Inc., Midland. The photographs of 1:20,000 scale were taken with a 12-in. focal length, automatic camera from a P-38 F5G photographic plane. The pipe line will connect Phillips' refinery in Phillips with the Denver marketing area.

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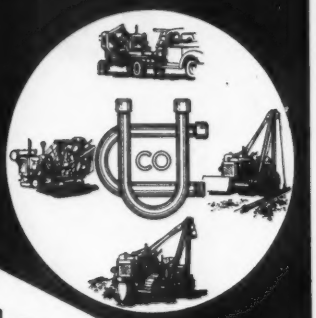

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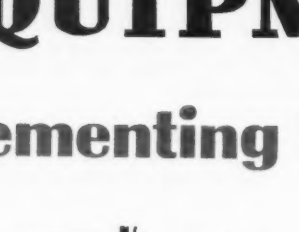

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NATURAL GAS

Program Announced for I.N.G.A.A. Annual Meeting

The subject of federal regulation of the natural-gas industry, particularly the place of the Federal Power Commission, is expected to take major attention at the annual meeting of the Independent Natural Gas Association of America November 22 at the Blackstone Hotel in Fort Worth.

Other topics to be discussed include gas reserves, problems of transportation, and the position of the royalty owner and the producer in the industry. The program for the 2-day meeting follows:

Morning session, 9:30 a.m.—The president's report, E. Buddrus, I.N.G.A. president; "The Natural-Gas Act," Mark H. Adams, chairman of the association's legal committee, lawyer, and independent producer of Wichita, Kans.; "Natural Gas and Its Future," E. S. Pettyjohn, director, Institute of Gas Technology, Chicago; "Natural-Gas Reserves," Dr. E. DeGolyer of DeGolyer & MacNaughton, Dallas; "Problems of Transportation," D. A. Hulcy, president, Lone Star Gas Co., Dallas,

Luncheon, 12:30 p.m. — Report of nominating committee; balloting on directors for 1947; report of Executive Director John A. Ferguson, Washington.

Afternoon.—"The Producer's Problems," Dr. Frank Dotterweich, Texas A. & I. College, Kingsville; "Viewpoint of the Royalty Owner," Homer W. Long, Guymon, Okla.; "Regulatory Practices," Judge P. A. Lasley, Little Rock, Ark.; report of resolutions committee.

5 p.m.—Election of officers for 1947. Board of directors meeting.

September Natural-Gas Sales Up 11.1 Per Cent

Sales of natural gas to ultimate consumers for September totaled 1,718,991,000 therms, representing a gain of 11.1 per cent over sales of 1,547,513,000 therms in the same month last year, according to the American Gas Association. For the 12 months ended September 30, sales of natural gas were 22,574,470,000 therms, equivalent to a loss of 1.4 per cent from sales of 22,894,660,000 therms in the like-year-earlier period. A.G.A.'s index of September natural-gas sales stood a 184.1 per cent of the 1935-1939 average.

A therm is a unit of measurement of gas supply which takes into account variation in heating value. One therm is approximately equivalent to 95 cu. ft. of natural gas.

Sales of all types of utility gas to ultimate consumers in September totaled 1,948,132,000 therms, an increase of 11.8 per cent over sales of 1,743,276,000 therms in the comparable month last year. The association's index of total gas utility sales stood at 179.4 per cent of the 1935-1939 average.

Engineer Says Texas Has Enough Laws

AUSTIN.—Texas has all the laws it needs for proration of natural gas, and proration already is in effect, Jack Baumel, chief engineer for the oil and gas division of the Texas Railroad Commission, testified last week before the Texas Senate's Gas Resources Committee, holding hearings on conservation and regulation of natural gas. The committee is to report to the next legislature on the possible need of new statutes and revision of tax rates. The inquiry was concerned primarily with the state's gas resources and of gas wasted in the production of oil.

Baumel pointed out that the Railroad Commission does not have statistics upon which to base an estimate of total gas reserves in the state. However, he said, that based on the average working pressure of 750 lb., as set by the Petroleum Administration for War, the reserve was approximately 78 trillion cubic feet as of January 1, 1946. Added to this are the 32 new pools discovered during the first 6 months of 1946.

Baumel told the committee that the average producing gas-oil ratio for Texas wells is 1,325 to 1, adding that he estimated from this that approximately 898,563,000 cu. ft. of casinghead gas was vented to the air in this state during August 1946.

Sen. T. C. Chadick, chairman of the committee, asked Baumel if he thought a bonus for gas injected, comparable to the East Texas salt-water bonus, would have merit. Baumel said he considered the Railroad Commission's allowance for gas used for legal purposes, such as light and fuel, to be a partial incentive.

Baumel said he thought Texas was about the only state that kept accurate records of gas produced. Texas, he said, could eliminate casinghead flares entirely if regulation were imposed, as in California, whereby all production of oil would be stopped until outlets were found for all gas produced with the oil. He added that such additional regulation would probably cause protests and the same sort of strife that attended the first imposition of oil proration in Texas.

Completion Uncertain for Gas Import Project

CHATHAM, Ont.—There is still uncertainty as to when construction work required in connection with the importation of Texas gas into Ontario will be completed, according to a statement just issued by Union Gas Co. of Canada. Contract has been let for laying the pipe line across Detroit River, and work has been started with sufficient pipe on hand to carry the gas from the crossing point to the company's Windsor plant.

Under the export permit, however, no gas can be exported from November to March. Until pipe is obtained to carry the gas from Windsor to the storage area in the Dawn field, less than half the quantity purchaseable can be taken. It will take from 1½ to 2 years with maximum contract deliveries to build up field pressure and reserves sufficient to meet the high winter peaks expected when house heating units are replaced on the line.

Gas Tax Case Decided

DALLAS.—The suit by the State of Texas against Phillips Petroleum Co. for $365,723.21, claimed as back taxes on an alleged difference in market value of Panhandle gas produced by Phillips from May 1, 1941, to September 30, 1946, as determined by the state comptroller and the producer, has resulted in a $100,000 judgment being handed down by District Court Judge Roy C. Archer.

Gas Hearing Again Delayed

WASHINGTON.—Another postponement of the Federal Power Commission hearing in Kansas City, Mo., on three proposed middle western gas-transmission projects was announced recently by FPC. The hearing is now set for November 25. The hearing will consider the construction applications of Cities Service Gas Co., Mid-Continent Gas Transmission Co., Northern Natural Gas Co., and also a Cities Service rate schedule.

STATISTICS and T

WEEKLY WELL COMPLETIONS . . . WEEK ENDED NOVEMBER 9, 1946

	Total of all wells					Cum.		Wildcat completions and discoveries					Cumulative total, 1946				
	Comp.	Oil	Gas	Dry	Footage	1946	1945	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
New York	31	15	0	*16	42,067	1,363	1,269	0	0	0	0	0	0	0	0	0	0
Pennsylvania	80	40	7	†33	122,033	3,423	3,516	0	0	0	0	0	0	0	0	0	0
West Virginia	11	2	7	2	28,166	641	691	0	0	0	0	0	0	0	0	0	0
Ohio	33	9	15	9	87,957	1,086	846	0	0	1	0	1	3	0	13	35	51
Indiana	3	0	0	3	8,120	318	166	0	0	0	0	0	4	0	0	16	20
Kentucky	8	5	0	3	17,412	406	474	0	0	0	1	1	7	0	0	34	41
Illinois	51	27	0	24	138,328	1,996	1,565	3	0	0	11	14	52	0	1	396	449
Michigan	10	1	2	7	21,998	694	656	0	0	0	6	6	20	0	7	222	249
Kansas	46	24	5	‡17	146,571	1,703	1,494	0	0	0	6	6	27	0	1	223	251
Neb., Mo., Iowa	2	0	0	2	1,706	18	20	0	0	0	1	1	0	0	0	13	13
Oklahoma	90	47	13	30	253,110	2,510	2,061	3	0	2	20	25	81	0	36	319	446
Texas	157	87	5	65	657,704	6,752	6,157	4	0	0	35	39	191	26	31	1,123	1,371
North Texas	65	27	0	38	170,880	2,387	1,875	2	0	0	19	21	66	0	4	462	532
West	37	30	0	7	196,864	1,493	1,509	0	0	0	3	3	46	0	1	149	196
Panhandle	0	0	0	0	0	273	470	0	0	0	0	0	0	0	0	5	5
Eastern	11	5	4	2	58,672	615	314	2	0	0	6	8	44	22	13	231	310
Gulf Coast	27	19	1	7	168,473	1,479	1,441	0	0	0	1	1	16	2	4	84	106
Southwest	17	6	0	11	62,815	505	548	0	0	0	6	6	19	2	9	192	222
Louisiana	31	19	0	12	201,357	1,188	921	2	2	0	2	6	45	13	7	161	226
Northern	15	10	0	5	52,742	672	385	0	0	0	0	0	9	0	2	88	99
Southern	16	9	0	7	148,615	516	536	2	2	0	2	6	36	13	5	73	127
Arkansas	2	1	0	1	6,271	153	154	0	0	0	0	0	7	0	0	32	39
Mississippi	7	4	0	3	62,276	211	317	0	0	0	3	3	1	0	1	59	61
Southeastern States	1	0	0	1	4,335	37	51	0	0	0	0	0	1	0	0	30	31
Montana	7	3	2	2	13,675	275	272	0	0	0	0	0	10	0	2	28	40
Wyoming	2	2	0	0	8,538	144	191	0	0	0	0	0	11	0	3	32	46
Colorado-Utah	1	1	0	0	6,450	137	48	0	0	0	0	0	4	0	0	16	20
New Mexico	6	5	1	0	21,832	346	367	0	0	0	1	1	4	0	0	34	38
California	15	11	.1	3	82,721	1,317	1,945	0	0	1	3	4	25	0	5	195	225
Total United States	594	303	58	233	1,932,927	24,718	23,181	12	2	4	89	107	493	39	107	2,978	3,617
Total previous week	552	273	57	222	1,796,044	24,124	22,653	15	1	1	87	104	481	37	103	2,889	3,510
Total Nov. 10, 1945	528	282	51	185	1,763,265			16	0	1	68	85	459	20	116	2,968	3,563

Service wells included: *16, †29, ‡1.

MARKET QUOTATIONS

GRAVITY SCHEDULES

Top prices include all gravities above grades designated, and low prices include all gravities below grades designated:

Gravity—	Signal Hill, Calif.	Oklahoma, Kansas	Gulf Coast Texas	West Tex.*
18-18.9	$1.17	....	....	....
19-19.9	1.21	....	$1.41	....
20-20.9	1.24	$1.20	1.43	1.07
21-21.9	1.28	1.22	1.45	1.09
22-22.9	1.32	1.24	1.47	1.11
23-23.9	1.35	1.26	1.49	1.13
24-24.9	1.39	1.28	1.51	1.15
25-25.9	1.43	1.30	1.53	1.17
26-26.9	1.46	1.32	1.55	1.19
27-27.9	1.50	1.34	1.57	1.21
28-28.9	1.54	1.36	1.59	1.23
29-29.9	1.57	1.38	1.61	1.25
30-30.9	1.61	1.40	1.63	1.27
31-31.9	....	1.42	1.65	1.29
32-32.9	....	1.44	1.67	1.31
33-33.9	....	1.46	1.69	1.33
34-34.9	....	1.48	1.71	1.35
35-35.9	....	1.50	1.73	1.37
36-36.9	....	1.52	1.75	1.39
37-37.9	....	1.54	1.77	1.41
38-38.9	....	1.56	1.79	1.43
39-39.9	....	1.58	1.81	1.45
40 and above	....	1.60	1.83	1.47

*Includes Lea County, New Mexico.

(Quotations shown here are f.o.b plant in tank cars and in cents per gal. as of last Monday.

REFINERY GASOLINE

Octane (A.S.T.M.)	78-78½†	73-75
Mid-Continent*	7.375-7.625	6.625-7.000
Tex. Gulf Coast	7.250	6.500-6.750
New York Harbor	8.750-9.500	7.750-8.500
California		6.250-6.750

*Basic Oklahoma Group 3. †1939 C.F R. (research method).

NATURAL GASOLINE

Grades—	26-70	18-55
Oklahoma (Group 3)	4.750	5.700
N. Texas (f.o.b. plant)	4.250	5.100
N. Louisiana (f.o.b. plant)	4.500	5.500
California (averages)	5.500	6.250

CRUDE-OIL PRICES

Representative posted schedules per bbl.

East Texas	$1.60
Kettleman Hills, California*	1.69
Beauregard Parish	1.55
Illinois Basin	1.72
Pecos County, Texas	1.30
Bradford, Pennsylvania	3.41
Eastern Ill., and Western Ind.	1.57

Note: Crude prices exclusive of sub-

A.P.I. REFINERY REPORT

Week ended November 2, 1946
(Figures in thousands of barrels)

	Daily crude runs to stills	Stocks Gasoline	Distillate	Residual
East Coast	707	19,638	24,704	12,423
Appalachian	163	3,280	783	644
Ill., Ind., Ky.	828	14,965	8,901	5,714
Okla., Kan., Mo.	376	8,742	3,374	1,357
Inland Texas	223	2,982	637	838
Tex. Gulf Cst.	1,189	13,144	10,785	8,150
La. Gulf Cst.	337	4,595	3,649	2,394
N. La., Ark.	65	1,500	480	216
Rocky Mtn.	130	1,448	583	710
California	751	15,636	12,047	29,202
Total 11-2-46	4,769	85,930	65,943	61,636
Total 10-26-46	4,758	86,423	65,499	60,872
Total 11-3-45	4,749	77,417	45,720	46,651

CRUDE-OIL STOCKS

(Bureau of Mines Estimate)

Week ended—	Bbl. of crude*
November 2, 1946	221,870,000
October 26, 1946	221,184,000
November 3, 1945	221,031,000

*Excludes unrefinable Calif. stocks.

TRENDS

DAILY AVERAGE PRODUCTION FOR WEEK

	Nov. 9 crude oil	B. of M. Nov. demand	Nov. 2 crude oil
Alabama	1,000	1,200	1,000
Arkansas	78,650	77,000	78,050
California	869,500	850,000	876,900
Colorado	38,310	32,000	36,850
Eastern	70,500	64,200	66,750
Florida	.....	200	.....
Illinois	206,950	212,000	210,250
Indiana	19,400	19,000	18,900
Kansas	267,450	263,000	279,100
Kentucky	30,100	29,000	30,100
Louisiana	406,750	382,000	402,000
North Louisiana	97,400	.....	96,400
South Louisiana	309,350	.....	305,600
Michigan	45,000	46,000	48,845
Mississippi	77,100	60,000	77,505
Montana	24,080	24,000	24,650
Nebraska	750	800	750
New Mexico	100,500	99,000	99,100
Oklahoma	363,250	383,000	362,450
Texas	2,102,250	2,090,000	2,046,550
District 1 (Southwest)	19,000	.....	19,450
District 2 (Southwest)	147,200	.....	144,800
District 4 (Southwest)	226,300	.....	214,300
District 3 (Gulf Coast)	464,300	.....	449,300
District 5 (Eastern)	36,850	.....	40,000
District 6 (Eastern)	105,100	.....	102,450
East Texas field	324,000	.....	316,000
District 7C (West)	29,500	.....	27,450
District 8 (West)	512,750	.....	484,700
District 7B (W. Central)	35,300	.....	33,500
District 9 (N. Central)	121,400	.....	129,700
District 10 (Panhandle)	80,550	.....	84,900
Wyoming	104,320	97,000	107,980
Miscellaneous other	.....	600	.....
Total United States	*4,805,860	4,730,000	4,767,730

Change from prev. wk., up 38,130

Total production January 1-November 9 ..... †1,486,495,854 bbl.
Same period last year (crude, plus condensate) 1,471,522,775 bbl.
*Not incl. 23,350 bbl. condensate. †Incl. 7,530,900 bbl. condensate.

CRUDE-OIL STOCKS 221,870,000 bbl. as of November 2—up 686,000 bbl. One year ago 221,031,000 bbl.

GASOLINE STOCKS 85,930,000 bbl. as of November 2—down 493,000 bbl. One year ago 77,417,000 bbl.

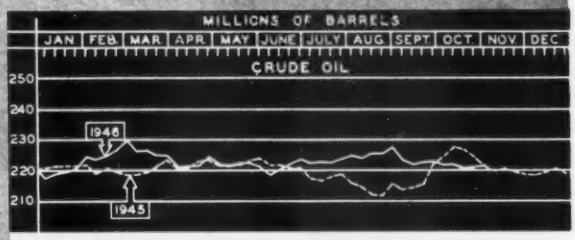
RESIDUAL FUEL-OIL STOCKS 61,636,000 bbl. as of November 2—up 764,000 bbl. One year ago 46,651,000 bbl.

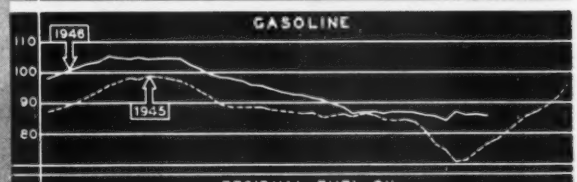
GAS OIL AND DISTILLATE STOCKS 65,943,000 bbl. as of November 2—up 444,000 bbl. One year ago 45,720,000 bbl.

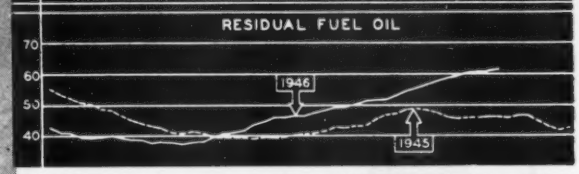
CRUDE-OIL PRODUCTION 4,805,860 bbl. as of November 9—up 38,130 bbl. One year ago 4,459,650 bbl.

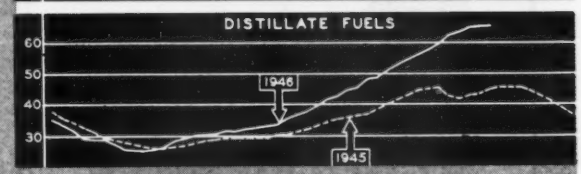
REFINERY RUNS 4,769,000 bbl. daily week ended November 2—up 11,000 bbl. One year ago 4,749,000 bbl.

OIL STOCKS IN THE UNITED STATES

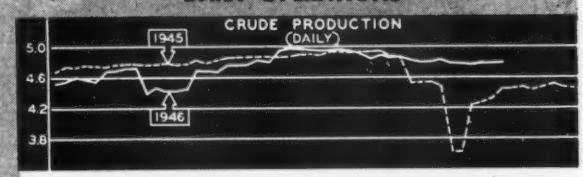


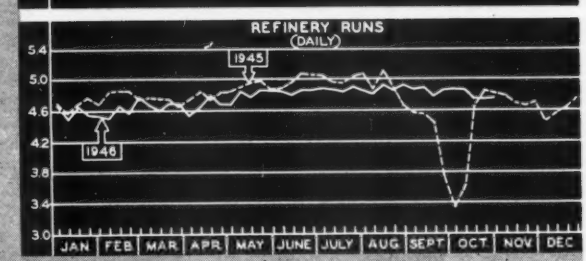




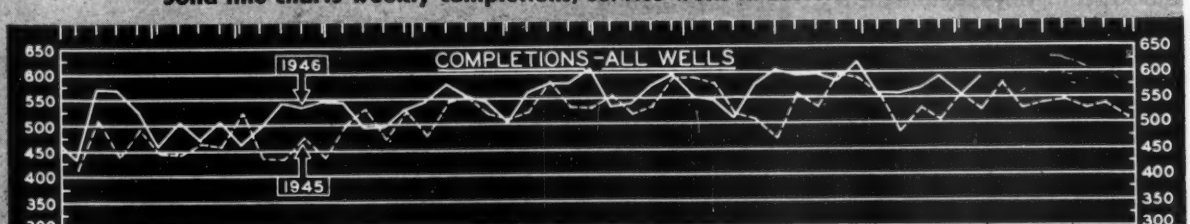


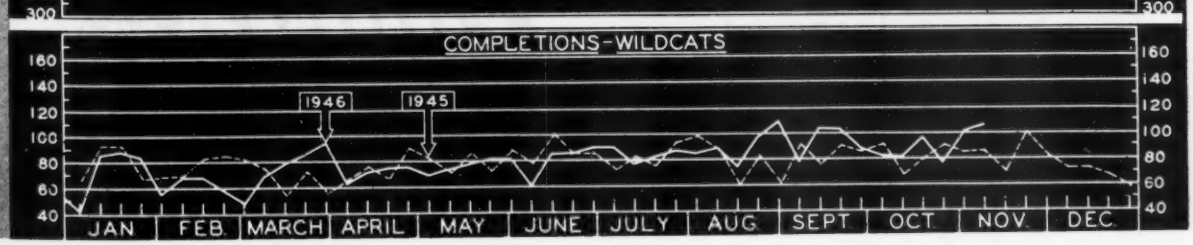
DAILY OPERATIONS

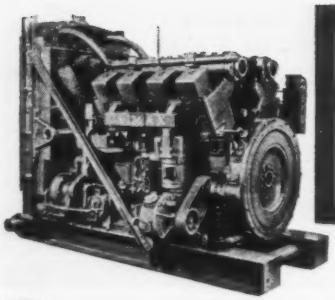




Solid line charts weekly completions, service wells in Eastern area included.







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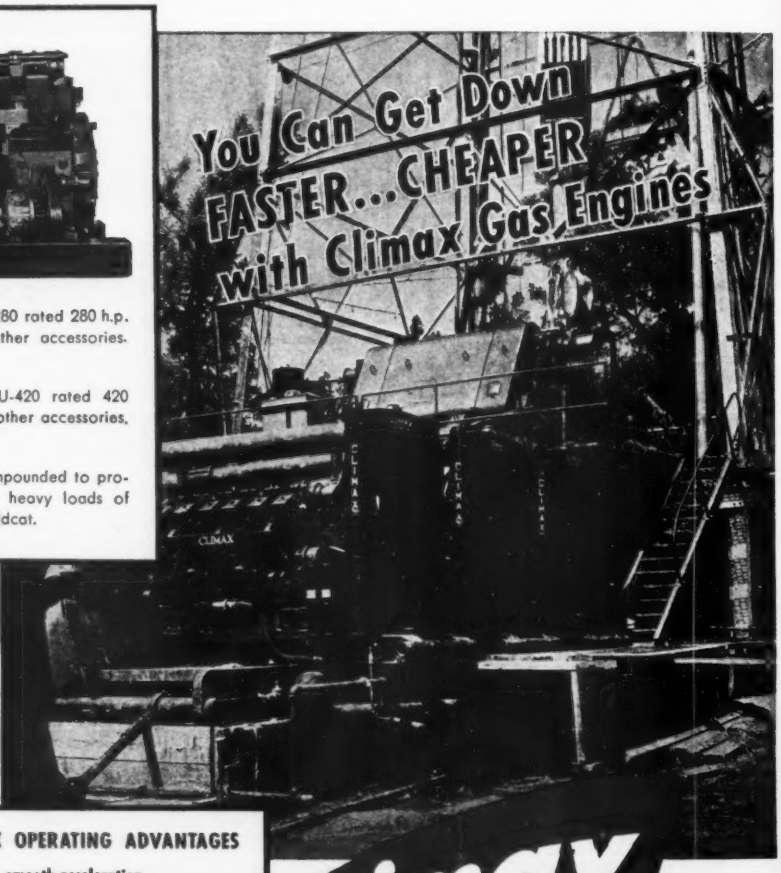
ABOVE: Heavy duty, compact Climax VU-420 rated 420 h.p. at 1100 r.p.m. with radiator, fan and other accessories. 12 cylinder, 4 cycle, "V" type.

AT RIGHT: 3 Husky Climax VU-420's (compounded to produce 1250 h.p.) speed-up drilling—hoist heavy loads of drill pipe fast—on this deep East Texas wildcat.



DRILLING CREWS KNOW the power and snap of Climax "V" Type engines. Know how quickly and easily they hoist heavy loads of drill pipe—how they lug through overloads—and *keep on doing a job* under toughest field conditions.

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Exploration and Drilling

Exploration and Proven Reserves

WE are in the midst of the greatest exploration campaign in the history of the United States. The objective is to build up a more comfortable position in the proven reserves back of our high production. These reserves are our working inventory of raw material. We are not in a tight inventory position, like the automotive industry; ours is merely slightly uncomfortable, resulting from wartime conditions.

At a time like this, proven-reserve figures come in for considerable discussion, and some people question the methods used in reporting them by the American Petroleum Institute and The Oil and Gas Journal. The issue is our method of giving new discoveries in any given year only the small reserve around the discovery well and such other wells as have been completed by the year's end. As drilling in later years proves up more reserves, these are taken care of by "revisions" in those later years.

There is another system, used for special purposes by a few private companies, and adopted by Petroleum Administration for War during the recent conflict. In this system, as any given pool is expanded, all increases in reserves are credited back to the year the first well was discovered. One claim made is that this method shows up the years in which new oil finding was most effective. The system has its usefulness, but some of its advocates claim too much.

If oil finding was most effective in the years in which the biggest pools were first discovered, and all subsequent revisions of their reserves are to be credited back to the discovery year, then 1930 and 1928 must be rated first and second for both Texas and the United States. East Texas came in in 1930; Agua Dulce in 1928, was the earliest discovery of the South Texas giant field (see The Oil and Gas Journal, November 9, 1946, page 60). Or 1919 must have been Colorado's best year, since Rangely's shallow oil came in then.

The logic is poor. It is doubtful if 6,600-ft. wells could have been drilled in Rangely in 1919; the 1928 South Texas infant has been developed to its present giant potentialities through the use of seismograph, modern coring and drill-stem techniques, electric logging, and the latest petroleum-engineering developments.

Every man who has ever attempted to promote a wildcat, or draw up a budget for an exploration and wildcat campaign, knows that there are times when it is comparatively easy to get financial support, and other times when it is extremely difficult. The questions of "when" and "why" it is easy or difficult can be answered in two ways.

One is that it is easy when supply is below demand or about in balance while demand is increasing; it is hard when conditions are reversed. The other answer is statistical, using proven reserves and current production to measure the industry's working inventory. When proven reserves are less than 13½ times current annual production, it is fairly easy to promote exploration and wildcatting; when these reserves exceed 13½ times annual production, it becomes progressively more dfificult.

Both the A.P.I. and the Journal method of estimating reserves reflect the year when the additions to or subtractions from previous estimates actually take place. Hence they reflect the time period when there is enough change in reserves to affect the economic picture and thus the size of the exploration campaign. Rangely had no such effect in 1919; nor did Agua Dulce in 1928; and while East Texas came fast, it was not dominant in the 1930 picture.

For economic purposes, to afford a base for measuring the industry's working inventory each year, and thus determining the kind of an exploration campaign needed, the method of estimating proven reserves used by the A.P.I. and the Journal is the more desirable.

EASTERN TEXAS

Wood County Test Finds Show in Rodessa Section

DALLAS.—Humble Oil & Refining Co.'s Smackover lime test, the 1 McKnight, James Survey, located on the north flank of the Hawkins Woodbine sand pool of southeastern Wood County, reported the following tops: With elevation of 350 ft., the Glen Rose was at 7,153 ft., Massive anhydrite 8,629 ft., Rodessa section 8,942-70 ft., the top of which showed for possible gas-distillation production, and the Pettit lime which was topped at 9,410 ft.

In Smith County, 1 mile east and north of Mount Sylvan field production, Delta Drilling Co. 1 W. H. Boynton, J. J. Smith Survey, was still looking toward the Paluxy and drilling below 5,216 ft. Sample tops were: Austin 4,580-4,610 ft., and Woodbine, carrying water, 5,210-16 ft. This well is checking low to producers in the Mount Sylvan field and is separated from the field by several dry tests drilled to the Paluxy.

Among the 14 first reports last week were a number of exploratory tests. In Henderson County, Humble Oil & Refining Co. was moving in materials for a Woodbine, or deeper, wildcat 1 mile west of Stockard and 5 miles northwest of Athens. The test will be the 1 W. J. Benge, in the W. D. Ratliff Survey. Location is 4 miles east of a test last year which stopped at 8,326 ft. in the Travis Peak after finding the Woodbine at 3,880 ft. and the Paluxy at 5,800 ft.

EAST TEXAS WILDCAT FAILURE

Kaufman County: Baron S. Barnes 1 Bettie Coleman, Jose D. J. Travine Sur., 4 mi. N of Mabank, dry, TD 5,631 ft., no shows, electric log tops: Woodbine 3,675 ft., Georgetown 4,360 ft., Paluxy 5,500 ft., elev. 418 ft.

SOUTHWEST TEXAS

Condensate Field Found In Hidalgo County

CORPUS CHRISTI.—In the area 6 miles southwest of Donna, in Hidalgo County, Stanolind Oil & Gas Co. 1 Harry Landa is a new wildcat discovery well. On a 15-hour drill-stem test, the well flowed 57 bbl. of condensate and 12 bbl. of water through 3/16-in. bottom choke and ¼-in. top choke, with 1,443,000 cu. ft. of gas, ratio 25,300 to 1, and top working pressure 1,180 lb. This flow was through perforations at 8,380-96 ft. and operators continue to test this zone. Total depth is 9,512 ft., with the 7-in. casing set at 8,490 ft. This test is in the Del Gato grant.

Argo Oil Co. 3-A Birdie B. Riley, in the south flank area at La Gloria field, Brooks County, is opening a new deeper pay zone for the field. The well started flowing in 9 minutes on drill-stem test through perforations at 6,970-71 ft., and flowed for 1½ hours, recovering 1,000 ft. of 42°-gravity oil, with no water. Operators are now running tubing for completion. This well failed to produce oil in the regular oil pay zone, and was deepened to 7,406 ft.

Henshaw Bros. and E. H. Smith 1 H. N. Schwartz et al, wildcat in John McMullen Survey, 2 miles northeast of Lucas field, in Live Oak County, is flowing clean oil, and testing into the tanks, to open new oil production. Top of pay was at 4,011 ft. Operators had difficulty in shutting off the water in the flow. Production is through perforations near the 4,020-ft. level. Operators are now taking potential gage.

The 38 new locations reported this week

included 10 wildcats, 2 each in Duval, Refugio, Live Oak, and Webb counties, and 1 each in Caldwell and San Patricio counties. Sixteen new oil wells were completed, 1 gas and 12 dry holes. Two new pay sands were opened, 1 in Midway field, and 1 in West Sinton field, both in San Patricio County. Six dry wildcats were completed, two in Duval, three in Webb, and one in Starr counties. Duval County received the greatest activity this week, reporting seven completions.

SOUTHWEST TEXAS SUCCESSFUL WILDCATS

San Patricio County: New oil pay, Midway field—F. M. Boykin, Jr. 3 H. H. Hutto, Sec. 81, Geo. H. Paul's subd. of Coleman-Fulton Pasture lands, TD 6,057 ft., top pay 5,680 ft., perf. 5,685-86 ft., IP 164 bbl. oil per day through a 9/64-in. choke, gas-oil ratio 1,380 to 1, TP 1,060 lb., casing sealed, gravity 31°.

New oil pay, West Sinton field—Jones & Morgan 1 W. Ford, Block 29, J. J. Welder subd. John Pollan sur., TD 5,231 ft., top pay 3,460 ft., perf. 3,462-68 ft. IP 151 bbl. net oil through ¾-in. choke, no gas, TP 50 lb., CP 1,400 lb., gravity 21°, 89.7 per cent water.

SOUTHWEST TEXAS WILDCAT FAILURES

Duval County: Hewit & Dougherty 1 Peter McBride, Lot 4, Block 20, Addition 5, Realitos subd. of Copita Farm & Garden tracts, Santos Garcia grant, 2½ mi. SE of Realitos, dry, TD 5,615 ft.

H. H. Howell 4 Lizzie Singer, SK&K Sur. 241, 5 mi. N of Benavides, dry, TD 2,438 ft.

Starr County: Sun Oil Co. 1 Pedro G. Rodriquez, Share 10, La Sal Colorado grant, dry, TD 7,505 ft.

Webb County: Dulaney Oil Co. 2 Frost National Bank, in A. Chapa Sur. 604, 1 mi. W of Mirando City field, dry, TD 1,808 ft.

O. W. Killam 2 E. Garcia Heirs, Sur. 2363, 6 mi. SE of Mirando City, dry, TD 1,957 ft.

Magnolia Pet. 2 Billings Ranch, CCSD&RGNG Sur. 52, Block 1, 14 mi. NE of Oilton, dry, TD 3,020 ft.

N. CENTRAL TEXAS

Venture in Noodle Creek Area Nearing Ellenburger

WICHITA FALLS.—Top of the Ellenburger was expected late last week at Roark, Hooker & Roark 5 J. M. Winters, a wildcat test in the Noodle Creek area, 12 miles northwest of Merkel. Operators are hopeful of establishing Ellenburger production but if that zone is found dry, will plug back to test in the Palo Pinto lime, which showed for production. On last report it was drilling below 4,900 ft. in the lime.

In Palo Pinto County, northeast of Strawn, a new gas pool was found at Palo Pinto Oil & Gas Corp. 1 A. Popp et al, Section 54, Block 2, T&P Survey. Flow of gas was not given, but pressure was said to be 1,600 lb. Production was from 3,772 ft., with no oil reported.

In Grayson County, The Texas Co.'s 4 J. R. Handy, 10 miles northwest of Gordonville, Samuel Stewart Survey, in the Delaware Bend shallow area, cored from 1,727-45 ft. Recovery was 16 ft. of oil sand with shale streaks. A drill-stem test at 1,712-45 ft. showed gas in 9 minutes and in 20 minutes recovered 70 ft. of oil-cut mud. Bottom-hole pressure was 300 lb. Coring recovered 19 ft. of oil sand at 1,782-1,801 ft. On last report, cores below 1,801 ft. showed the sand to run out at 1,808 ft. A drill-stem test at 1,768-1,814 ft., open 40 minutes, returned 85 ft. of oil-cut mud and showed a bottom-hole pressure of 475 lb.

In Haskell County, 3 miles northeast of the Lawson field, T. D. Humphrey 1 E. O. Chapman was flowing into pits at an estimated 10 to 20 bbl. of oil an hour. Total depth is 5,470 ft. in lime, with casing set at 4,240 ft. and perforated at 4,070-82 ft. After swabbing dry, the hole filled 20 bbl. with oil over night, after which it was acidized with 2,000 gal. Swabbed for 8 hours, the fluid level remained constant at 3,000 ft.

NORTH CENTRAL TEXAS SUCCESSFUL WILDCATS

Cooke County: R. B. Hollingsworth 1 H. E. King, M. Langham Sur., 4 mi. S of Myra, pumped 10 bbl. oil a day, sand 1,005-10 ft., TD 1,010 ft.

Young County: L. T. Burns 2 C. Ellis, S½ Sec. 207, TE&L Co. Sur., 4½ mi. SE of Olney, pumped 9.6 bbl. of 40°-gravity oil a day, sand 755-58 ft., TD 769 ft.

NORTH CENTRAL TEXAS WILDCAT FAILURES

Archer County: Harvey Drilling Co. 1 Abercrombie & Taylor "F," J. W. Harris Subd., 8 mi. SW of Archer City, dry, TD 1,480 ft. in sand and shale.

Harvey Drilling Co. 1 C. L. Abercrombie "M," Blk. 108, J. W. Harris Subd., 4½ mi. W of Archer City, dry, TD 1,467 ft. in sand and shale, Gunsite lime 1,363-68 ft.

Harvey Drilling Co. "N" Abercrombie, Blk. 109, J. W. Harris Subd., 4½ mi. W of Archer City, dry, TD 1,460 ft. in sand and shale, Gunsite lime 1,353 ft., shale and light show oil in sand 1,359-66 ft. and 1,403-08 ft.

Fred M. Manning 1 Carrie Mahler "B," Lucien Hofson Sur., 7 mi. SW of Wichita Falls, dry, TD 5,538 ft., elev. 992 ft., sand with light odor 4,785 ft., hard lime 5,455 ft., no shows.

Clay County: L. T. Burns 1 G. P. Graner, R. W. Tyre Sur., 5 mi. NE of Bluegrove, dry, TD 6,445 ft. in lime and shale, elev. 972 ft., no tops reported.

J. B. Wells 1 J. B. Wells, Blk. 32, Bacon Subd., 3 mi. S of Charlie, dry, TD 198 ft. in shale.

Cooke County: Benson Bros. 1 F. B. Bordovsky, A.C.C. Bailey Sur., 3 mi. E of Gainesville, dry, TD 4,058 ft. in lime, elev. 805 ft., sand with show of oil 2,315-25 ft.

Sun Oil Co. 1 O. P. Cason, J. L. Hodges Sur., 10 mi. SE of Gainesville, dry, TD 3,770 ft. in lime and shale, elev. 666 ft., slight show of oil in sand and shale 3,397-3,405 ft.

Wilbarger County: Gulf Oil Corp. 6-E Blackman, W. A. McKinney Sur., 8 mi. S of Vernon, dry, TD 3,548 ft., elev. 1,253 ft., show of oil in lime at 2,776-2,802 ft.

Young County: F. B. Paine Drilling Co. 2 Huffman, Sec. 1,442, TE&L Co. Sur., 1 mi. N of Jean, dry, TD 620 ft. in water sand.

WEST CENTRAL TEXAS WILDCAT FAILURES

Coleman County: Roy H. Denhart 1 Fred Haynes, L. L. Shields Sur., 1 mi. NW of Trickham, elev. 1,432 ft., dry, TD 2,023 ft., Fry sand 1,080 ft., Caddo lime 1,242 ft., Ranger lime 1,721 ft., Ellenburger 2,000 ft.

Eastland County: Graham, Spears & Graham 1 George P. Fee, Sec. 64, Blk. 4, H&TC Sur., 4 mi. NE of Cisco, dry, TD 2,150 ft. in shale, dry sand 1,760 ft.

Erath County: McCarthy Oil & Gas Corp. 1 Wyatt Hedrick, Jesse Benton Sur., 5½ mi. SW of Bluff Dale, elev. 1,041 ft., dry, TD 7,165 ft., Caddo 4,105 ft., Ellenburger 4,628 ft., Hickory 7,002 ft., granite wash 7,145 ft.

Fisher County: T. A. Kirk and L. H. Choate 1 T. G. Stephenson, John Rodman Sur., 1 mi. SE Longworth, old total depth 4,054 ft., drilled to new total depth 6,116 ft., dry, top Ellenburger 6,055 ft.

Jones County: George Waite 1 Howard Burgeson, HT&B Sur., 1 mi. N of Lueders, elev. 1,562 ft., dry, TD 1,995 ft., Dotham lime 1,331 ft., Flippen sand 1,712-15 ft.

West Central Drlg. Co. 1 E. Duke, Sec. 23, Blk. 15, T&P Sur., 5 mi. S of Anson, elev. 1,728 ft., dry, TD 2,910 ft. in shale and lime, Gunsight 2,500 ft., Swastika sand 2,605 ft.

Shackelford County: H. F. Pettigrew 1 S. L. Philly, Bayland Orphan Asylum Sur., 1 mi. SE Hamby, elev. 1,778 ft., dry, TD 1,937 ft., lime with slight show of gas 880-900 ft.

Roeser & Pendleton 2-A-36 Cook, Sec. 36 ETRR Sur., 7 mi. NW of Albany, elev. 1,492 ft., dry, TD 1,243 ft. in shale.

Taylor County: Ungren & Frazier 1 C. Reynolds, T&P Sur., 2 mi. NW of Merkel, elev. 1,873 ft., dry, TD 3,164 ft., Flippen sand 2,746 ft., Swastika 3,137 ft.

PERMIAN BASIN

Test in Block 12 Field Swabs Oil From Devonian

MIDLAND.—Prospects of Devonian production in the Block 12 field of Andrews County were increased last week when Atlantic Refining Co.'s 1-E Texu, Section 18, Block 12, on the west side of the field, swabbed and flowed an average of 7 bbl. of oil an hour, with some water, in the Devonian. Drilled to total depth of 8,817 ft. in the lower Devonian, it plugged back to 8,710 ft. and perforated at 8,454-80 ft., 8,490-8,540 ft., and 8,550-70 ft., with a total of 96 holes. After perforating, the well was acidized with 7,000 gal. Water was said to be coming from a faulty cement job higher in the hole and operators were confident of shutting it off.

Globe Oil & Refining Co.'s wildcat, the 1 Lockhart & Brown, in central Andrews County, 6 miles south of production in the Fullerton field, amended its application to the Railroad Commission and will continue on to 9,000 ft. to test the Devonian. A drill-stem test at 7,290-7,510 ft., open 1 hour, recovered 120 ft. of slightly oil and gas-cut mud, with no water. On last report it was drilling below 7,942 ft. in lime.

In northeast Crockett County, Stanolind Oil & Gas Co.'s wildcat, the 1-GG University, some 12 miles southeast of Barnhart, was reported swabbing open hole to test at plugged back total depth of 8,377 ft. In 12 hours it swabbed 135 bbl. of salt water and 45 bbl. of oil. Fluid level was 1,000 ft. from the surface and casing pressure was 425 lb. After swabbing down, the hole was loaded with 316 bbl. of oil. The test kicked off and flowed 1½ bbl. of load oil an hour, with casing pressure of 450 lb. Operators are continuing tests.

In Reeves County, Argo Oil Corp. 1 Dora Roberts, 13 miles northeast of Balmorrhea, was drilling out bridge at 11,000 ft. Previous to a cavein, it had swabbed and flowed 28 bbl. of oil and 12 bbl. of water in 2½ hours.

In Edwards County, Ray Pool 1 Sid Peterson, located 15 miles northeast of the town of Rocksprings, recovered 120 ft. of drilling mud, with no shows of oil, gas or water, on a 29-minute drill-stem test in the Ellenburger at 4,756-95 ft. The formation was reported as dense and hard, with no fractures.

First reports for West Texas last week totaled 28, exclusive of gas tests, in 17 counties, including 6 wildcats in as many counties. This compared with 24 new wells the previous week.

WEST TEXAS WILDCAT FAILURES

Andrews County: Mid-Continent Pet. Corp. 1 A. P. Culbertson, Sec. 10, Blk. A-47, PSL Sur., 4½ mi. SW of Fullerton field, dry at 7,630 ft., electric log tops: Yates 3,100 ft., San Andres 4,610 ft., Glorietta

5,890 ft., Tubb sand 6,920 ft., elev. 3,312 ft.

Dawson County: Ray Albaugh 1 Lillian Scanlon, Sec. 85, Blk. M, ELRR Sur., in NW corner of county, dry, TD 5,000 ft. in lime, DST at 4,882-4,962 ft. recovered 75 ft. of mud, no shows, elev. 3,131 ft., no tops reported.

SOUTHEASTERN NEW MEXICO

HOBBS.—Two wildcat operations are being watched in southeastern New Mexico. Skelly Oil Co. 2 Steeler, NE NE 17-23s-37e, on the southwest side of the Drinkard pool in Lea County. This test was dry at total depth of 7,200 ft. early this year but operators decided to deepen. On last report it was below 8,720 ft. in dolomite.

Another test drilling deeper is Sun Oil Co.'s 1-B McKinley, on the north side of the Hobbs field, 20-18s-38e, which was drilling below 7,119 ft. in what was said to be the lower Permian. Old total depth here was 4,242 ft., with an elevation of 3,657 ft. At 5,596-5,680 ft., in the Glorietta, this well made a slight blow of air, with no gas, and recovered 60 ft. of oil and 440 ft. of heavily oil-cut mud. Shut-in bottom-hole pressure was 1,750 lb. with the packer set at 6,097 ft., the test was swabbed for 48 hours, and recovery was a slight amount of drilling fluid and water, and only a scum of oil.

CALIFORNIA

Wildcat in Miramonte Area Nearing State Depth Record

LOS ANGELES.—The California drilling-depth record will fall this week unless unexpected difficulties are encountered in Pacific Western Oil Corp. et al 1 National Royalties, 5-26s-22e, Kern County, which was last reported drilling at 16,125 ft. At current depth, the Pacific Western wildcat which is in the Miramonte area, east of the Lost Hills pool, is 120 ft. above the previous record drilling depth in California.

A new discovery in the Edison area of Kern County awaited production test. The new well is O. F. Darling et al 1 McNear, 1-31s-29e, about 3 miles east of the south end of the Mountain View field and the same distance south of the Edison field. Operators are building storage after making a brief production test which resulted in an unestimated volume of oil and gas considered of commercial proportions.

Two new wildcat operations were started during the week. They are General Petroleum 1 Moran, 30-22n-26e, about 5 miles east of the Pixley area in Tulare County, and Bandini Petroleum Co. is starting a wildcat in the Jasmine area of Kern County. The Bandini location is in 35-25s-27w.

Another new wildcat project authorized last week is Palomar Petroleum Co. 1 Tyrell, in 13-6s-4w, Riverside County, about 4 miles east of Elsinore.

Gas production appeared likely from Amerada Petroleum Corp. 1 Wineman, 35-6n-2e, Solano County, after formation test resulted in flow of 5,000,000 cu. ft. of gas daily at total depth of 4,795 ft.

Testing operations are under way at Kings County Oil Co. 1 E. C. vonGlahn, a wildcat operation in the Alpaugh area of Kings County. Operators have suspended drilling at 13,213 ft., but are testing intervals higher in the hole. An attempted test from 12,542-50 ft. failed and operators are continuing efforts to determine what productive possibilities exist at that point.

There were only 33 new locations spotted in California last week, a reduction of nearly 30 per cent. Four new locations authorized by Shell Oil Co., Inc., in the Ventura field represented the greatest concentration of drilling operations.

CALIFORNIA SUCCESSFUL WILDCATS

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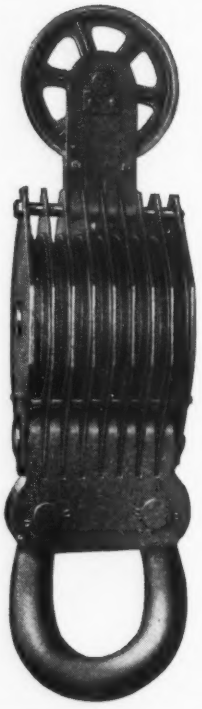

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CALIFORNIA WILDCAT FAILURES

Orange County, Olinda area: Wood-Callahan Oil Co. 1 Coyote, 4-3s-9w, dry, TD 1,975 ft.

Kern County, Buena Vista Lake area: Seaboard Oil Co. et al 73-14 SWUM-BVA, 14-32s-25e, dry, TD 12,553 ft.

Stanislaus County, Ripon area. Tide Water Associated Oil Co. 34-16 Overton, 16-3s-7e, top Eocene 3,500 ft., Blewett sand, 4,850 ft., dry, TD 6,054 ft.

TEXAS GULF COAST

Deep Production Opened In Altair Field

HOUSTON.—Deeper production has been opened in the Altair pool of Colorado County by Superior Oil Co. A-4 Mrs. Myra S. Pryor, in BBB&C Survey, Abstract 710. Drilled to a total depth of 10,366 ft., the well flowed 133 bbl. of 50°-gravity condensate along with 4,600,000 cu. ft. of gas through a 16/64-in. tubing choke. Flowing pressure on tubing was 3,050 lb., with shut-in pressure of 3,600 lb. Condensate ratio was 40,000 to 1. Production is from perforations at 10,174-92 ft. On drill-stem test through perforations at 10,105-32 ft. the well flowed 1,000,000 cu. ft. of gas per day along with distillate and mud, through ¾-in. top choke. Gas and condensate, along with salt water, was recovered through perforations at 10,138-52 ft.

D. M. Wallace 1 J. W. Kubella, wildcat, Wharton County, 1¼ miles east of Lakeview (Hutchins) field and 1 mile west of production in the Kubella field, flowed 75 bbl. of oil daily with good pressure on drill-stem test through 12 perforations at 4,671-73 ft. On previous test through perforations at 4,700-04 ft., the well flowed at the rate of 5 bbl. of oil, 25°-gravity, per hour through a ⅛-in. choke top and bottom. Total depth is 6,000 ft. with 5½-in. casing set at 4,760 ft.

Humble Oil & Refining Co. 1 Lulu R. Scherer, in J. Poitevent Survey, 1,400 ft. southwest of the Lula Wallis 1 discovery well of South Mayes field, Chambers County, made an initial flow test through 30 perforations at 9,224-29 ft. and flowed 1,444,000 cu. ft. of gas with no fluid content. Flow was through a ½-in. choke and had 3,100 lb. flowing pressure on the tubing with 3,200 lb. pressure on the casing.

Only one wildcat start was reported this week, along with six development locations. The wildcat is in Brazoria County. North Thompson field in Fort Bend County received two locations, Saratoga in Hardin County one, West Ranch in Jackson County one, Esperson in Liberty County one, and Lakeview in Wharton County one. Six dry wildcats were completed, three in Chambers, and one each in Fort Bend, Jackson and Montgomery counties. Jackson and Fort Bend counties received the greatest activity with three completions each.

UPPER GULF COAST WILDCAT FAILURES

Chambers County: Gulf Oil Corp. 2 W. F. Mayes et al, in Lost Lake area, Victor Blanche Sur., just south of Liberty County line, dry, TD 8,290 ft.

John W. Mecom 2-B E. Ker Cade et al, in C. T. Cade Sur., dry, TD 8,707 ft.

Texas State Drilling Co. 1 D. Lundguist Unit, H&TB Sur., 1½ mi. W of Elm Bayou gas production, dry, TD 6,878 ft.

Fort Bend County: H. M. Amsler 1 Mary C. Beirne et al, in Needville area, H&TC Sur. 75, dry, TD 4,705 ft.

Jackson County: Hewit & Dougherty 1 Jennie Williams estate, Wm. Whitaker Sur., 10 mi. N of Edna, dry, TD 4,760 ft.

Montgomery County: Humble 1 W. M. Wickizer, in Jos. P. Harrison Sur., 4½ mi. SW of New Caney, dry, TD 11,320 ft.

MISSISSIPPI

Tests Unsuccessful at Lincoln County Wildcat

JACKSON.—In Lincoln County, Crescent Drilling Co. 1 J. F. Vernon, 31-8n-7e, reached total depth at 10,636 ft., and set 7-in. casing at 10,636 ft. to test. Perforations were made at 10,463-86 ft., packer at 10,430 ft., and with ¼-in. chokes top and bottom, it recovered 3,000 ft. of water cushion in 1 hour and 30 minutes, blew for 25 minutes, then died. Another test recovered water cushion and four stands of heavy mud. It was washed and mud replaced with oil. When opened it flowed for 6 hours and decreased to a small stream. When swabbed down, fluid rose 800 ft. in 5 minutes. Operators will squeeze perforations.

In Holmes County, Mid-Continent Development Co. 1 Sam D. Hall, 23-13n-3e, was shut down at 5,071 ft., total depth. Formation tops were: Clayton 3,580-3,610 ft., chalk 3,650-80 ft., Eutaw 4,430-60 ft.

New locations for the week were: Adams County two, Lamar one, Lincoln five, Ran-

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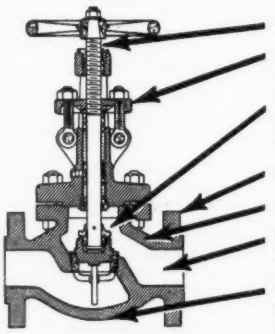

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kin one, and Wayne one. One location for Morgan County, Alabama, was reported.

MISSISSIPPI WILDCAT FAILURES

Adams County: Ohio Oil Co. 1 Geo. W. Armstrong, 12-5n-3w, dry, TD 11,070 ft., Cook Mountain 3,227 ft., Sparta 3,485 ft., Wilcox 4,644 ft., Midway 7,955 ft., 1st sand 10,272 ft., Marine Tuscaloosa 10,510 ft., Basal Marine Tuscaloosa 10,902 ft., Massive sand 10,987 ft.

Green County: Humble Oil & Refining Co. 1 W. W. Greene, SE SW 27-2n-6w, dry, TD 9,207 ft., Wilcox 2,305 ft., Midway 4,600 ft., Eutaw 6,808 ft., 1st sand 6,912 ft., Lower Tuscaloosa 7,972 ft., Massive sand 8,102 ft.

Madison County: Magnolia Petroleum Co. 1 G. Heindl, C N/2 NE SE NE 21-9n-3e, dry, TD 7,484 ft., Wilcox 1,532 ft., Midway 3,795 ft., conglomerate 4,600 ft., Eutaw 5,662 ft., Tuscaloosa 6,260 ft.

APPALACHIAN FIELD

Kanawha County Well Finds Production in Oriskany

PITTSBURGH.—In Elk district, Kanawha County, West Virginia, Columbian Carbon Co. drilled through the Oriskany sand in 887 W. P. Morris with a high gage of 1,831,000 cu. ft. and final gage of 379,000 cu. ft. before shot. Surface elevation is 721 ft., Corniferous Lime 4,905 ft., Oriskany 5,017 ft., and total depth 5,087 ft.

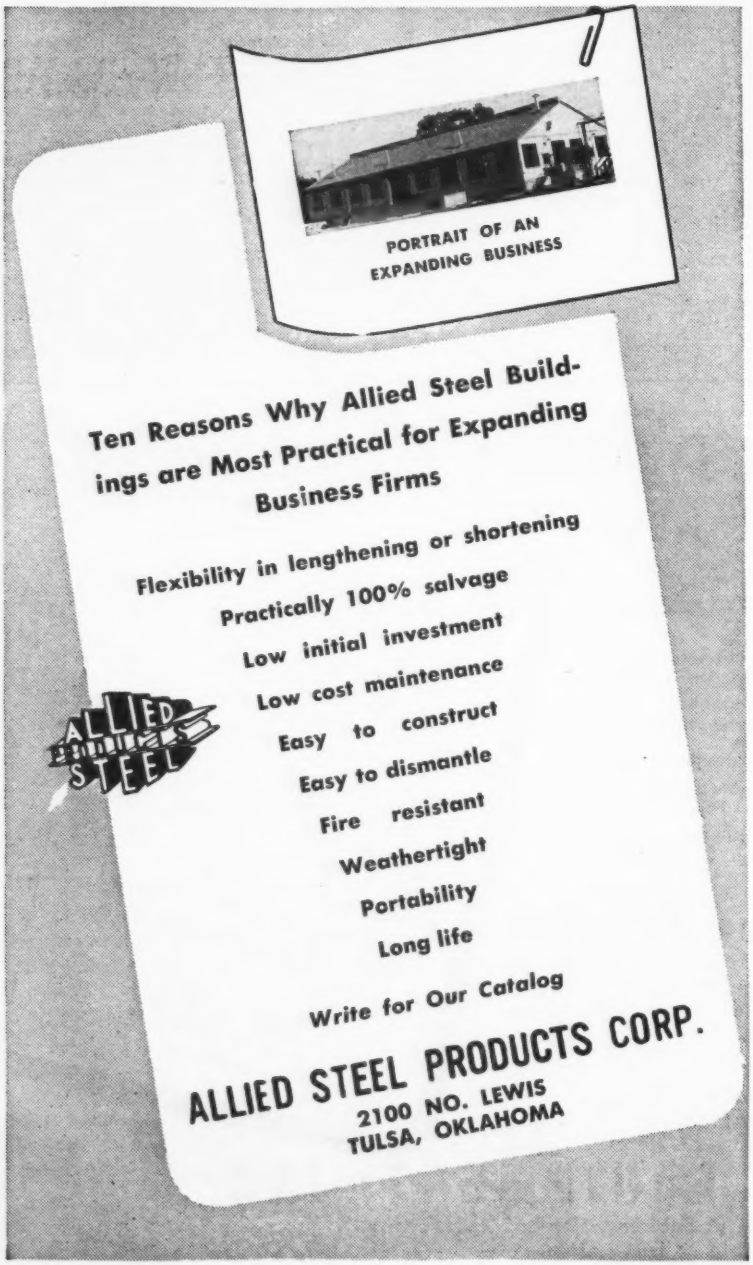
In Mountain Cove district, Fayette County, Godfrey L. Cabot, Inc., has an interesting test drilling on Susan Kincaid farm which has reached a depth of 5,723 ft. with the Salt sand at 1,136-1,255 ft., Maxton 1,537-1,621 ft., and Big Lime 1,861-2,148 ft. It appears scheduled for the lower Devonian and will be the first such test in the district. One drilled in Kanawha district in 1929 may have reached the Oriskany but struck water in the Corniferous lime.

In Baileysville district, Wyoming County, James W. Harmon completed a test on fee with a final open flow, natural, of 2,412,000 cu. ft. gas from the Berea topped at 3,460 ft. Total depth is 3,475 ft.

New locations totaled 27 and were located in Boone, Calhoun, Fayette, Jackson, Kanawha, Lincoln, Marion, Nicholas, Pleasants, Putnam, Ritchie, Summers, Wayne, Wetzel, Wirt, Wood, and Wyoming counties.

In Springhill Township, Greene County, Waynesburg Tool Co. et al completed the test W. G. Miller which after shot in the Gordon Stray sand filled up 1,200 ft. in the hole with oil. The oil was struck at 3,167 ft. The well drilled through the Bayard sand to 3,600 ft., and is estimated good for 15 bbl.

New locations totaled six and were located in Armstrong, Clarion, Washington, and Westmoreland counties.



CANADIAN FIELDS

Continued Exploration In Western Ontario Justified

CHATHAM. — Announcement has been made by Dr. O. B. Hopkins, vice president of Imperial Oil, that the results of drilling in western Ontario in the past 1½ years have justified the continuation of the search for commercial oil. Near-commercial showings of oil have been secured in the area north and west of Chatham, and in addition a large gas well has been opened in the same area. In the past 18 months, some 12 wells have been drilled in the Chatham-Oil Springs-Petrolia area extending north and south through Kent and Lambton counties.

Steveville. — In the Steveville - Princess field, southeastern Alberta, South Princess-C.P.R. 3, LSD 12, 8-19-11w4, got Madison limestone at 3,315 ft. and halted drilling at 3,320 ft., with initial gas flow around 1,000,000 cu. ft. and a 930-ft. rise of black crude in 1 hour, indicating a flow between 240 and 360 bbl. a day. Casing has been set preparatory to acidizing and testing. There was no water. Location is 1½ miles north and a mile west of South Princess 2 discovery well, limestone being met 24 ft. lower.

Pinhorn Dome.—On the Pinhorn Dome in southern Alberta, near the Montana boundary, McColl-Union 11-A, LSD 11, 35-2-8w4, has finished coring in the Bow Island sand to 2,182 ft. with drill-stem test indicating around 5,000,000 cu. ft. gas. Rig will be moved to McColl-Union 10-B, LSD 10, 22-4-9w4, 4 miles northwest of the proven gas area.

Keystone Valley.—On the Keystone Valley structure in the central foothills, Roxana 3-K, LSD 7, 31-27-6w5, has been thrown so seriously off vertical by an underground rock slide that drilling has been suspended and the rig skidded 1,100 ft. east for a new test. After several drill rods in succession were twisted off around 2,919 ft., a survey of the hole disclosed abrupt deviations at that depth and 2,970 ft., neither of which was indicated when casing was set at 4,992 ft. in September. At 4,992 ft. the well was approaching the Blairmore formation. The original well is to be left intact, so that work may be resumed later. One previous incident of a subterranean rock slide occurred some years ago in Turner Valley.

Central Plains.—In the Alberta central plains area, two new tests are starting. McColl-Frontenac Oil Co. is drilling McColl-Wetaskiwin 1 in LSD 4, 11-45-25w4, 8 miles southwest of Wetaskiwin, as a test

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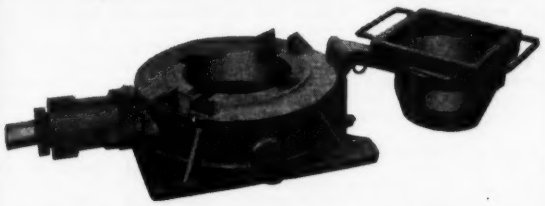

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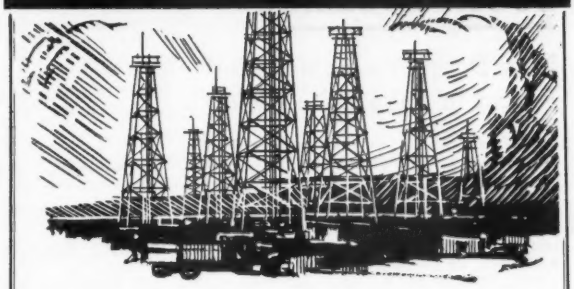

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of the Devonian limestone. Imperial-Leduc 1, LSD 5, 22-50-26w4, 10 miles south of Edmonton, is also to be a Devonian test. Farther north, Imperial-Deville 1, LSD 9, 36-51-20w4, has been abandoned at 3,636 ft., and Imperial-Deville 2 spotted in LSD 13, 36-51-19w4.

Youngstown. — In south-central Alberta, Imperial-Youngstown 1, LSD 5, 3-30-9w4, drilled to 3,789 ft. and, failing to get production in the Devonian, has plugged back to 3,001 ft. The Cretaceous formation will be tested for gas to supply Youngstown.

Lloydminster. — Several wells in the Lloydminster field are being serviced for production. Husky Refining 4, near Lone Rock, in the Saskatchewan portion of the field, will take production from a saturated sand just below the casing at 1,830 ft. with indications of a large producer. A productive gas sand above the oil was cased off. About 2½ miles southeast, Qithers-Lone Rock, LSD 13, 6-47-26w3, is waiting for servicing. D. B. 1, between the original Lloydminster field and Lone Rock, indicates good production and is waiting for pumping equipment.

SOUTH LOUISIANA

New Deep Producing Sand Found in Lake Pelto Field

NEW ORLEANS.—A new deep producing sand for the Lake Pelto field, Terrebonne Parish, has been opened by The Texas Co. 50 State-Lake Pelto, on State Lease 188, 16-23s-18e. On potential gage it flowed 82 bbl. of 47°-gravity condensate and 1,487,000 cu. ft. of gas daily through a 12/64-in. choke. Flowing pressure on the tubing was 2,100 lb. and gas-condensate ratio was 15,853 to 1. Total depth is 12,602 ft. and production is through 54 perforations at 12,397-12,415 ft.

British-American Oil Producing Co. 1 A. M. Dupont Corp., in Lapeyrouse field, Terrebonne Parish, has been completed in a new deep sand with a potential flow of 162 bbl. of 52°-gravity water-white condensate through a 12/64-in. choke, with 3,365,000 cu. ft. of gas, ratio being 20,772 to 1. Drilled to a total depth of 13,879 ft., the well is producing from new deep sands at 12,640-662 ft., with perforations at 12,654-62 ft.

The Texas Co. opened a new deeper sand in the LaFitte field, Jefferson Parish, when its 6 Geo. H. Kerner, 22-17s-24e, was completed in oil sand from 10,391-10,426 ft. Drilled to a total depth of 10,759 ft., this well flowed a potential of 243 bbl. of 36°-gravity oil per day through a ⅛-in. choke, tubing pressure 1,250 lb. Production is through 60 perforations at 10,404-15 ft.

A new deep sand has been opened by A. J. Bankhead et al 1 Charles Dischler, in the North Ritchie field of Acadia Parish, 17-7s-1w. On potential gage the well flowed 239 bbl. of 32°-gravity oil through a ⅛-in. choke with 1,850 lb. flowing pressure on the tubing and a gas-oil ratio of 2,500 to 1. Total depth is 9,104 ft. and production is through 30 perforations at 9,053-58 ft. Gas sand was encountered from 8,470-85 ft.

Sixteen new locations were reported this week, three of which are wildcats, one each in Evangeline, LaFourche, and West Baton Rouge parishes. Bayou De Fleur field in Jefferson Parish, and Golden Meadow field in LaFourche Parish each received two new starts. Nine oil wells were completed, four being new sand openers, and seven dry holes, two of which were wildcats. The new sands are in North Richie field, Acadia Parish, LaFitte in Jefferson Parish, and Lake Pelto and Lapeyrouse in Terrebonne Parish.

SOUTH LOUISIANA SUCCESSFUL WILDCATS

Acadia Parish: New oil sand, North Richie field—A. J. Bankhead et al 1 Chas. Dischler, 17-7s-1w, TD 9,104 ft., perf. 9,053-58 ft., top sand 9,051 ft., IP 239 bbl. per day through 8/64-in. choke, gas-oil ratio 2,500 to 1, TP 1,850 lb., 32° gravity, 0.2 per cent water.

Jefferson Parish: New oil pay, Lafitte field The Texas Co. 6 Geo. H. Kerner, 22-17s-24e, TD 10,759 ft., oil sand 10,391-10,426 ft., perf. 10,404-15 ft., IP 243 bbl. oil per day through a ⅛-in. choke, TP 1,250 lb., gravity 36°, 0.1 per cent water.

Terrebonne Parish: New gas-condensate pay, Lake Pelto field—The Texas Co. 50 State-Lake Pelto, Lease 188, 16-23s-18e, TD 12,602 ft., perf. 12,397-12,415 ft., IP 82 bbl. day through a 12/64-in. choke, and 1,487,000 cu. ft. gas per day, gas-oil ratio 15,853 to 1, TP 2,100 lb., gravity 47°, no water.

New gas-condensate pay, Lapeyrouse field—British-American Oil Producing Co. 1 A. M. Dupont Corp. 15-20s-18e, TD 13,879 ft., perf. 12,654-62 ft., IP 162 bbl. condensate per day through 12/64-in. choke, and 3,365,000 cu. ft. gas per day, gas-condensate ratio 20,772 to 1, TP 3,950 lb., gravity 52°.

SOUTH LOUISIANA WILDCAT FAILURES

Acadia Parish: Barnsdall Oil Co. 1 Ozeman Young, 31-7s-2w, between Tepetate and West Tepetate fields, dry, TD 9,450 ft.

Ascension Parish: Atlas Oil & Refg. Corp. 1 Wheeler & Wortham, 48-10s-14e, dry, TD 9,627 ft.

ROCKY MOUNTAIN

Snow Storm Halts Drilling In Rocky Mountain Area

DENVER.—A snow storm accompanied by high wind, described as the worst in 33 years, crippled drilling operations east of the mountain ranges from Montana to New Mexico the past week. Almost every well in Cut Bank and Kevin-Sunburst was shut down, and similar conditions prevailed through northern Wyoming and eastern Colorado on down into New Mexico. Operations west of the mountains were not seriously affected.

Cedar Creek.—Drilling operations of the Montana-Dakota Utilities Co. the past few months on the southeastern end of the 67-mile long Cedar Creek (Baker-Glendive) anticline in eastern Montana have carried shallow gas production 8 to 10 miles into the southwestern corner of North Dakota. Two dry holes completed last month, however, appear to have determined the southeastern limits of the pool. Early in 1941 three gas wells were completed in SW SW 36-131n-107w, and NE NW and SW NE 2-130n-107w at 1,450 to 1,600 ft. in the Eagle sandstone of upper Cretaceous age, the production being 125,000 cu. ft., 280,000, and 200,000 cu. ft., the pressure being around 405 lb. Last year 3 wells in Sections 24 and 25-130-107 and 5-129-106 extended the proven area still farther to the southeast. Two months ago it further was extended by 2 wells in C NE Section 8 and NW NW 9-129-106. Last month 2 dry holes in NE SW Section 9 and C NE 16-129-106 were abandoned at 1,500 and 1,380 ft. Deep tests much farther to the northwest drilled several years ago yielded small production in the Madison at around 8,600 ft.

Elk Springs discovery.—Continental Oil Co. 1 Smith, SE SW 30-5n-98w, Elk Springs structure, Moffat County, Colorado, 28 miles northeast of the Rangely field, which topped the Weber at 6,087 ft., now looks as though it will make a small well in the upper section, probably 100 to 150 bbl. per day before being shot. It was drilled to 6,231 ft. and encountered water in the lower section. The water has been shut off after plugging back to 6,140 ft., and the upper section below the 7-in. at 6,090 ft. swabbed 39 bbl. of clean oil in 16 hours and is still testing.

Rangely field. — The allowable in the Rangely field was cut as of November 1 from 175 to 150 bbl. per well per day, a reduction of 50 per cent in the past 3 months. A subcommittee of the Rangely engineering committee is expected to recommend shortly a change in figuring the allowable to include bottom-hole pressure and other production factors. A few wells on the southeastern side have been put on the pump recently.

San Juan Basin deal.—Delhi Oil Corp., subsidiary of Southern Union Gas Co., was high bidder, with a bid of $40.50 an acre, on a 4,000-acre block of Ute Mountain Tribal land unsurveyed in Township 32n-14w, La Plata County, Colorado, on the north end of the Barker Creek structure, San Juan County, New Mexico, where Southern Union has 4 big gas wells in the lower Pennsylvanian at 9,000 ft. This lease is 30 miles west of Stanolind Oil & Gas Co. 22,000-acre block near Ignacio in 33n-7 and 8w.

New operations. — Ten new operations were reported, of which four were in the Rangely field in Colorado, one each at Zimmerman Butte, Gebo and Great Divide in Wyoming, and one each in Bowdoin, Cat Creek and Kevin-Sunburst in Montana. The only wildcat was Carter Oil Co. 1 Government, C NE NE 13-26n-93w, Great Divide structure, Sweetwater County, Wyoming, 15 miles south of the Crook's Gas and 20 miles west of the Lost Soldier fields. It will be a deep test on a 30,000-acre block. Location was made after 2 years of geophysical work in the area.

Completions.—Eleven wells were completed, of which 7 were oil wells with initial production of 879 bbl., 2 were gas wells, and 2 were dry holes. Colorado had one completion in Rangely for 292 bbl. Wyoming had 2 completions, 1 at Garland and the other at Zimmerman Butte, both oil wells, for 297 bbl. Montana had 8 completions, of which 4 were oil wells, 2 in Cut Bank, 1 in Cat Creek, and 1 in Kevin-Sunburst for 290 bbl., 1 gas well in Bowdoin and another in Cedar Creek, and 2 dry holes in Cedar Creek and Cat Creek. There were no wildcat completions.

MICHIGAN

Exploration Ventures Continue Shy of Success

SAGINAW.—Michigan crude-oil production from established fields holds steady, but new drilling operations continue shy of successes. The past week brought only 10 completions and 1 small new crude producer. Two gas wells and 7 dry holes, 6 of which were wildcat tests, made up the rest of the completions report as 13 new locations were started. Four of the new locations are in Allegan County, two each in Isabella and Bay, one each in Livingston, Van Buren, Montcalm, Oceana and Genesee.

MICHIGAN WILDCAT FAILURES

Allegan County, Dorr Township: Sleep & Broughton 1 Ed Homrich, SW SW NE 5-4n-12w, dry in Traverse, TD 1,777 ft.

Heath Township: Wayne C. Prather 1 F. J. Durand, NW SE SE 25-3n-14w, dry in Traverse, TD 1,524 ft.

Huron County, Dwight Township: Charles W Teater 1 Frank M. Bleicher, C S½ SE NE 20-18n-13e, dry in Monroe, TD 3,377 ft.

Oceana County, Crystal Township: Charles W. Teater 1 Ralph Aldrich, SW SE NE 16-16n-16w, dry in Traverse, TD 1,831 ft.

Ottawa County, Jamestown Township: H. J. Hurzel 1 A. and J. Geukes, SW SW SE 12-5n-13w, dry, TD 1,055 ft.

Wexford County, Cherry Grove Township:

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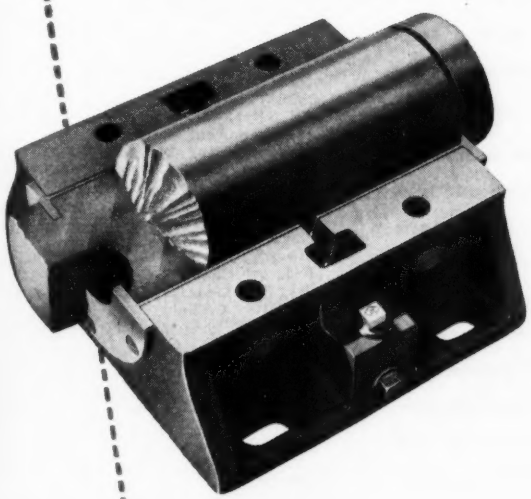

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Sun Oil Co. 1 Aden D. Dill, NE NE SW 28-21n-10w, dry in Detroit River, TD 4,020 ft.

OKLAHOMA

Hunton Extended Northward In Southwest Wayne Pool

THE Sinclair Prairie 1 Haney, SW NE SW 24-5n-2w, created considerable interest among Oklahoma operators during the past week when it came in flowing at the rate of 1,000 bbl. a day from the Bois d'Arc section of the Hunton lime. Located in the Southwest Wayne pool of McClain County, the 1 Haney is the second Hunton producer for the pool, and is just north of the discovery which is producing from the Pennsylvanian.

The 1 Haney was perforated with 210 holes opposite the upper section of the Hunton at 6,635-70 ft., acidized with 3,000 gal., and made two tests, flowing an average of 100 bbl. of 44°-gravity oil per hour through a 27/64-in. choke. On the first test gas was measured at 4,500,000 cu. ft. daily for a gas-oil ratio of 1,570 to 1. When the well was shut in following the test, tubing pressure rose to 1,175 lb., and casing pressure to 750 lb. During the second test casing and tubing pressure was 650 lb. with gas recorded at 4,050,000 cu. ft.

Hunton production was opened in the pool by the Big Chief Drilling Co. 1 Community White, NW SW SE 24-5n-2w. The Big Chief 1 Stephens, SE SW 24-5n-2w, opened the pool in the Pennsylvanian in August. One other well in the pool is now testing the Hunton. It is the Big Chief 1 White, NE SE SE 23-5n-2w, which is making about 15 to 17 bbl. of oil an hour following a 2,000-gal. acid treatment at 6,667-90 ft.

Superior Oil Co. of California 51-11 Weller, NW NW NE 11-8n-12w, Caddo County wildcat, continued to set a new depth record for the state as it drilled ahead below 15,030 ft. At this depth it was 448 ft. below the former record.

Operations in every area of the state were slowed during the past week as the result of recent heavy rains. Greatly affected was the Cotton County play, where roads are bad through most of the county. Considerable new work still is being planned for the area, however, as 31 new locations were announced during the past week, 9 of which were wildcats.

OKLAHOMA WILDCAT FAILURES

Carter County: C. W. Tomlinson 1 Hollingsworth, SW NW SW NW 26-5s-1e, dry, TD 400 ft., Bromide dense 18-125 ft., sand 289-343 ft., Tulip Creek 348 ft.

Cotton County: J. W. Baldwin 1 Rodgers-Watkins, NW NW NE SW 29-2s-10w, dry, TD 2,508 ft., sand 1,285-200 ft., 1,390-405 ft. and 2,162-49 ft., lime 2,350-59 ft. and 2,384-90 ft.

C. P. Burton 1 Branch, NW SW NW 18-3s-11w, dry, TD 2,105 ft., sand 1,677-89 ft. and 1,761-81 ft., lime and shale 1,781-97 ft., black shale 1,797-809 ft., shale and lime 1,809-28 ft., shale with hard sand streaks 1,952-2,015 ft.

R. E. Barbre et al 1 M. E. Parrish, NE NE NW NE 13-2s-12w, dry, TD 2,370 ft., granite wash 1,850-55 ft., lime 2,139-43 ft., sand 2,289-314 ft.

R. L. Fisher 1 Dugan, NW NW SW SW 5-5s-12w, dry, TD 2,157 ft., sand 1,513-35 ft. and 1,568-72 ft., Megargel lime 1,585-602 ft., Canyon lime 2,143 ft.

Fortex Oil Corp. 1 Stanford, NW SW NE 5-5s-12w, dry, TD 2,301 ft., Megargel lime 1,700 ft., Canyon 2,290 ft.

Kingery Brothers 1 McMahon, NW NW NW NW 33-1s-11w, dry, TD 2,510 ft., sand 2,109-25 ft. with an odor of gas, lime 2,355-94 ft.

J. R. Meeker et al 1 Powell, SW NE SE 6-3s-12w, dry, TD 2,012 ft., sand 1,295-310 ft., lime 1,934-63 ft.

E. W. Whitaker 1 Zweiacker, NE NE SE NW 20-3s-12w, dry, TD 2,263 ft., sand 1,335-55 ft., white lime 1,408-21 ft., sand 1,469-77 ft., lime 1,580-86 ft., sand 1,648-50 ft.

McClain County: Lewis Oil 1 Gordon, SE SE NE 21-7n-2w, dry, TD 5,989 ft., no tops reported.

Mid-Continent 1 Henderson, SE NE SW 14-5n-2w, dry, TD 7,223 ft., Oread 4,430 ft., Belle City 5,080 ft., Hogshooter 5,510 ft., 1st Deese 6,334 ft., 2nd Deese 6,540 ft., Woodford 6,996 ft., Bois d'Arc 7,111 ft., Haragan 7,148 ft.

McIntosh County: Texola Drilling Co., Inc., 1 J. A. Cannon, C NE SE 7-11n-17e, dry, TD 1,941 ft., Simpson sand 773-80 ft. with a slight show of gas, sand and lime 780-83 ft., sand 886-904 ft. and 1,530-55 ft.

Osage County: Ohio Oil 1 Osage, SE SW SW 1-22n-11e, dry, TD 2,104 ft., Big Lime 997-1,084 ft., Oswego 1,177-225 ft., Red Fork 1,483 ft., Inola 1,552 ft., Bartlesville 1,558-70 ft., brown lime 1,625 ft., Burgus 1,763 ft., Mississippi lime 1,772 ft., Simpson 2,041 ft., Arbuckle 2,067 ft.

A. G. Oliphant 2 Osage, NE NE NW 10-24n-10e, dry, TD 2,133 ft., Big Lime 1,432-510 ft., Oswego 1,628 ft., broken sand 1,956-82 ft., lime 1,991-93 ft., broken sand 1,993-2,028 ft. and 2,092-97 ft., chat 2,097-117 ft., Mississippi lime 2,117 ft.

Payne County: Home Gas 1 School Land, SE NE SE 36-18n-4e, dry, TD 3,685 ft., Hogshooter 2,390 ft., Layton 2,456 ft., Checkerboard 2,715 ft., Big lime 3,111 ft., Oswego 3,122 ft., Prue 3,235 ft., Verdigris 3,396 ft., Lower Skinner 3,438 ft., Red Fork 3,484 ft., Inola 3,600 ft., Bartlesville 3,614 ft.

Pontotoc County: W. J. Dillon 1 Byrd, NE SE SW 35-3n-7e, dry, TD 2,750 ft., McLish lime 2,403 ft., Wilcox 2,730 ft.

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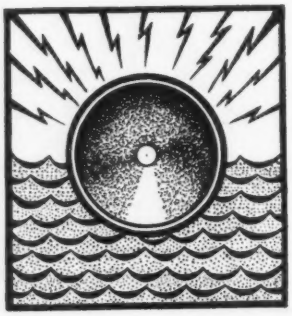

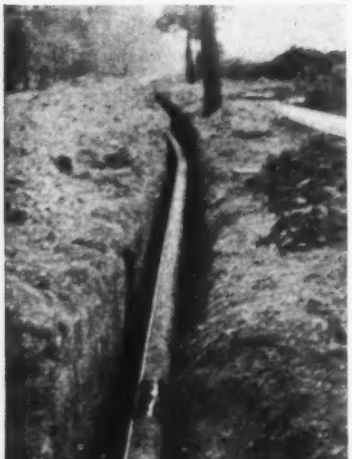

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Seminole County: Big Chief Drilling 1 Jimmie, SW SW NE 2-5n-6e, dry, TD 2,531 ft., Calvin 1,235 ft., Earlsboro sand 2,053 ft., Pennsylvanian Caney 2,460 ft.

Kingery & Patterson 1-A Davis, NE NW SE 10-11n-8e, dry, TD 3,617 ft., brown lime 3,200 ft., Booch 3,300 ft., Gilcrease 3,500 ft., Cromwell 3,601-17 ft., sandy shale 3,617 ft.

Sohio 1 E. F. Reed, SE SE NW 29-10n-7e, dry, TD 3,785 ft., brown lime 3,603 ft., Booch 3,645-62 ft., Gilcrease 3,713-32 ft., Cromwell 3,760 ft.

Texola Drilling Co., Inc., 1 W. D. Baker, NW NW SW 9-8n-7e, dry, TD 100 ft., no tops reported.

OKLAHOMA SUCCESSFUL WILDCATS

Hughes County: B. C. Deardorf 1 Miller, SE SE SE 5-7n-9e, flowed 60 bbl. of 38.8°-gravity oil per day through 2-in. tubing choke from Booch at 2,858-82 ft.; Senora 1,210 ft., Senora lime 1,280 ft., Allen 1,300 ft., Bartlesville 2,300 ft., brown lime 2,690 ft., TD 2,882 ft.

Oklahoma County: Magnolia 1 B. C. Honsel, C SW NW 10-12n-4w, extension to W. Edmond, flowed 63 bbl. of 41°-gravity oil through 2-in. tubing choke from Hunton at 7,160-75 ft.; Oread 5,025 ft., Tonkawa 5,220 ft., Checkerboard 6,275 ft., Oswego 6,815 ft., Prue 6,962 ft., TD 7,245 ft.

Payne County: Fleet & Roodhouse 1 Ball, NE NE SW 10-18n-3e, discovery 2 miles north of Mehan pool, flowed 34 bbl. of 38°-gravity oil through 5/16-in. tubing choke from Bartlesville at 3,931-49 ft.; Avant 2,520 ft., Perry Gas 2,560 ft., Layton 2,886 ft., Big Lime 3,480 ft., Oswego 3,564 ft., Prue 3,610 ft., TD 3,954 ft.

Pontotoc County: W. B. Pine Estate 1 Doner, SE NE SW 19-5n-7e, discovery 1 mile northeast of W. Francis pool, flowed 500,000 cu. ft. of gas per day from Therman sand at 1,498-502 ft.; Allen sand 1,260-70 ft. with a show of oil, Hunton 3,125 ft., Sylvan 3,206 ft., Viola 2,320 ft., Wilcox 3,623 ft., TD 3,700 ft.

Texas County: Cities Service Oil Co. 1 Buzzard, SW SW NE 28-4n-12ecm, produced 5,720,000 cu. ft. of gas from Lower Krider at 2,604-24 ft.; Upper Krider 2,578 ft., Ft. Riley 2,710 ft., Ft. Riley lime 2,725 ft., TD 2,852 ft.

LA.-ARK.

Catahoula Parish Wildcat Recovers Oil on Test

SHREVEPORT.—In Catahoula Parish, Penrod Drilling Co. 1 J. P. Mitchell, 36-8n-7e, had total depth at 9,471 ft. in shale. Drill-stem test at 9,317-46 ft. was open 18 minutes when packer failed. It recovered 4 bbl. of mud. Drill-stem test at 9,322-46 ft., through ¼-in. choke, recovered 2,800 ft. of water cushion in 25 minutes, with little pressure; recovered 570 ft. of mud cut with gas and oil, 190 ft. of light brown oil, estimated 40°-gravity, 120 ft. of mud cut with oil, gas and salt water, and 15 ft. of salt water. Bottom-hole flowing pressure was 1,825 lb. Cores at 9,397-9,407 ft. recovered soft, white sand. Formation tops reported were: Midway 6,532 ft., Upper Cretaceous 7,243 ft., base Austin 8,553 ft., Tuscaloosa 8,700 ft., sand 9,321-44 ft., Massive sand 9,394-9,430 ft., Lower Cretaceous 9,434 ft. Operators were running 5-in. casing on last report.

In Franklin Parish, Atlas Oil & Refining Co. 1 Ayer Timber Co., 26-14n-9e, was in shale at total depth of 7,037 ft. Casing was set at 6,684 ft., perforated at 6,572-86 ft., and a drill-stem test showed gas at the top in 1 minute. It flowed an unannounced amount of gas and distillate at a working pressure of 1,600 lb.

KANSAS

Gas Discovery Made in Rice County Silica Field

COURTNEY B. DAVIS has made an interesting gas discovery in the Rice County section of the Silica field with his 2 Dueser, NE NE SW 31-19-10w. After being worked over and plugged back, the 2 Dueser, an old oil producer, developed a flow of gas that gaged nearly 12,000,000 cu. ft. daily, leading to the possibility that a substantial gas pool may be developed in the middle of the 10-year-old oil field.

In plugging the well back to the Kansas City lime, an electric log showed porosity and stain at 3,172-90 ft., and a plug was set at 3,103 ft. The pipe was then ripped and the well given a 1,000-gal. acid treatment. As rods were being run, the well cleaned itself of the water load and a rock pressure of 960 lb. was developed within an hour, increasing to 1,030 lb. in 18 hours. The well flowed out of control for a day and a night and subsequently gaged 11,700,000 cu. ft. Davis now plans to test other wells on the Dueser lease for gas.

Exploratory interest in Marion County was maintained during the past week by the announcement of two new wildcat tests near the town of Marion. Machinery is in place for the S. & S. Oil Co. et al 1 Stallwitz, NW NE SE 2-20-4e, 8 miles north of the Florence pool, while location has been staked for the Dwight Wilson 1 Holub, NW SW SE 5-19-4e, 4 miles north of Marion.

An attempt to revive production in the old Gouldner pool has ended in failure at the Madel & Gussman 1 Gouldner, SE NW

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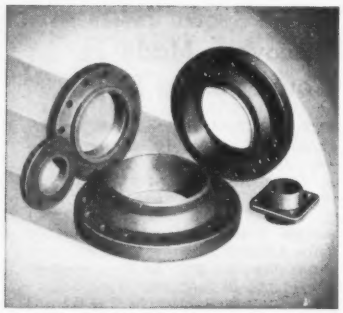

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SW 9-18-9w. A show of gas and water was logged in the white Lansing lime at 2,989-3,012 ft., but this proved to be of no commercial significance. Other tops were the conglomerate at 3,256 ft., Simpson sand at 3,269 ft., and the Arbuckle at 3,280 ft. Total depth of the well was 3,285 ft.

KANSAS WILDCAT FAILURES

Gove County: Ray B. Phelps 1 Wilson, NE NE NE 16-12s-30w, dry, TD 3,878 ft., Topeka 3,617 ft., Heebner 3,845 ft., Lansing-Kansas City 3,865 ft.

Norton County: Sohio Petroleum et al 1 Reeves, NE NE SW 3-2s-22w, dry, TD 3,755 ft., Topeka 3,276 ft., Heebner 3,392 ft., Lansing-Kansas City 3,424 ft., Basal Kansas City 3,629 ft., Arbuckle 3,702 ft.

McPherson County: W. L. Hartman 1 College, C N/2 NW NW 20-20s-1w, dry, TD 3,655 ft., Lansing-Kansas City 2,374 ft., Mississippi 2,986 ft., Kinderhook 3,300 ft., Misener 3,490 ft., Viola 3,495 ft,. Simpson shale 3,550 ft., Arbuckle 3,630 ft.

Rice County: Royer & Farris 1 Link, NW NW NW 9-20s-10w, dry, TD 3,415 ft., Lansing-Kansas City 3,094 ft., conglomerate 3,390 ft., Arbuckle 3,395 ft.

Sumner County: Deep Rock Oil 1 Watkins, NE NE SE 32-32s-4w, dry, TD 4,756 ft., Lansing-Kansas City 3,510 ft., Mississippi Lime 4,200 ft., Simpson 4,630 ft., Arbuckle 4,715 ft.

Trego County: Republic Natural Gas 1 Hille, SE SE SW 23-15s-24w, dry, TD 4,322 ft., Greenhorn 360 ft., anhydrite 1,707 ft., Ft. Riley 2,500 ft., Topeka 3,414 ft., Heebner 3,668 ft., Lansing-Kansas City 3,688 ft., Ft. Scott 4,190 ft., conglomerate 4,262 ft., Mississippi Lime 4,293 ft.

MISSOURI WILDCAT FAILURE

Caldwell County: Todd & Leuring 1 Benson, NW NE NW 30-55n-29w, dry, TD 1,306 ft., Basal Kansas City 369 ft., Mississippian 941 ft.

ILLINOIS

Shell Drilling Devonian Test in Rural Hill Field

MATTOON.—In the Rural Hill field of Hamilton County, Shell Oil Co. is drilling ahead in its Devonian lime test the 4 J. Nohava, SE SW NE 13-6s-5e. Drilling is now progressing below the 3,880-ft. mark, and formations encountered so far include the Barlow at 2,786 ft., Ste. Genevieve at 3,144 ft. and the St. Louis at 3,411 ft. This is the first deep test drilled in the field and it is being watched with considerable interest.

In Wabash County the Sam Malis et al 1 W. Fite, NE NW 7-1n-13w, has been officially completed in the McClosky lime at 2,813-20 ft., total depth, for an initial production of 900 bbl. per day natural. The 1 Fite is approximately 1½ miles west of nearest production in the Lancaster field and opens a new oil area.

Also in Wabash County, Magnolia has completed the 2 Pfeiffer, NE NW NE 11-2s-14w, two locations northeast of a recent discovery by the same company. The 2 Pfeiffer was completed in the Cypress sand at 2,679-84 ft., total depth, for an estimated initial production of 300 bbl. of oil a day natural. Operators have voluntarily prorated the well to 60 bbl. daily.

The Marine pool of Madison County has been given a short eastward extension by the G. T. Loper 1 Roding, NW NW NW 14-4n-6w. This well pumped 80 bbl. daily following an acid treatment of 100 gal. in the Devonian, topped at 1,759 ft. Total depth was 1,793 ft.

Illinois activity continued at a fast pace throughout the past week as operators finaled 51 wells, 27 of which were oilers

and the remainder dry holes. Wildcat completions totaled 14, and included 2 pool openers, 1 extension well and 11 dry holes. New operations announced during the week totaled 52, and included 11 exploratory ventures.

ILLINOIS SUCCESSFUL WILDCATS

Madison County: G. T. Loper 1 Roding, NW NW NW 14-4n-6w, pumped 80 bbl., 100 gal. acid, Devonian 1,759 ft., TD 1,793 ft.

Wabash County: Hayes & Wolf 1 L. E. Meyer, SW SW NW 8-1s-13w, pumped 140 bbl., 40-qt. shot 2,556-75 ft., Benoist sand 2,550-72 ft., TD 2,578 ft.

Sam Malis 1 Fite, NE NE NW 7-1n-13w, flowed 900 bbl., Rosiclare 2,813-20 ft., TD 2,824 ft.

ILLINOIS WILDCAT FAILURES

Clay County: Paul Doran 1 C. Guerrettaz, NW NW SE 31-5n-5e, dry at 2,754 ft., Glen Dean 2,088 ft., Cypress sand 2,283 ft., Benoist 2,436 ft., Aux Vases sand 2,491 ft., Ste. Genevieve 2,580 ft., Rosiclare 2,593 ft., McClosky 2,621 ft.

National Associated Petroleum Corp. 1 W. Muezynski, NW SW SE 8-5n-5e, dry at 2,490 ft., Glen Dean 2,206 ft., Benoist 2,343 ft., Aux Vases sand 2,418 ft., Ste. Genevieve 2,482 ft.

Hamilton County: C. E. Brehm 1 Wright, SW NW NE 11-4s-7e, dry at 3,468 ft., Tar Springs 2,617 ft., Glen Dean 2,637 ft., Cypress sand 2,997 ft., Benoist 3,123 ft., Aux Vases sand 3,252 ft., Ste. Genevieve 3,309 ft., Levias 3,336 ft., McClosky 3,433 ft.

Jefferson County: Collins-Langenkamp 1 White, SW NW SE 26-1s-2e, dry at 2,378 ft., Benoist 2,195 ft., Aux Vases sand 2,240 ft., Ste. Genevieve 2,302 ft., McClosky 2,370 ft.

Lawrence County: P. Supthin 1 Crews, SE NE SW 10-3n-11w, dry at 1,908 ft., Rosiclare 1,815 ft., Fredonia 1,832 ft.

Marion County: George McDivitt 1 Zollar, SW SW SW 30-3n-2e, dry at 2,046 ft., Renault 1,883 ft., Aux Vases 1,894 ft., Ste. Genevieve 1,974 ft., Rosiclare 1,989 ft.

T. B. Dirickson 1 Jackson, NW NW NE 24-3n-2e, dry at 2,442 ft., Menard 1,645 ft., Glen Dean 1,862 ft., Ste. Genevieve 2,326 ft., Fredonia 2,376 ft.

W. R. Britton 1 Bundy, NE NW NE 26-2n-1e, dry at 2,030 ft., Cypress sand 1,817 ft., Benoist sand 1,930 ft., Renault 1,977 ft., Aux Vases sand 1,982 ft.

Madison County: Paul Doran 1 Mindrup, NE NE NE 13-5n-7w, dry at 1,959 ft., Ste. Genevieve 947 ft., Devonian 1,888 ft., Silurian 1,953 ft.

Shelby County: E. P. Jarvis 1 D. Stewartson, SW NE NE 16-11n-4e, dry at 1,948 ft., Glen Dean 1,619 ft., Cypress sand 1,770 ft., Aux Vases sand 1,914 ft., Ste. Genevieve 1,924 ft.

Wayne County: Eagle Drlg. 1 Illinois Farm Corp., SW SW SE 15-1s-5e, dry at 3,124 ft., Rosiclare 3,090 ft., Fredonia 3,111 ft., McClosky 3,117 ft.

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OHIO, KENTUCKY

New Gas Field Opened In Coshocton County

COLUMBUS.—Benedum-Trees struck gas in the Clinton sand in a wildcat along the Bedford-Perry line in Coshocton County. The test, on John Lee, Section 16, Bedford Township, found Clinton at 3,350-92 ft. with 412,000 cu. ft., which 12 hours after shot gaged 694,000 cu. ft.

A new Berea sand pool was opened in Monroe County by M. A. Gaughan et al by their completion on K. A. Burgbacher, Section 15, Center Township. Berea at 1,805-22 ft. made 1,000,000 cu. ft. natural with 720 lb. rock pressure. A number of locations have been staked on adjoining tracts.

The Mifflin pool in Ashland County was extended ⅛ mile southwest by the Ohio Fuel 3 M. W. C. District, Section 23, Mifflin Township. Clinton at 2,411-21 ft. gaged 1,870,000 cu. ft. natural.

In the shale pool in Newton Township, Licking County, Ohio Fuel 1 E. O. Williams, third quarter, found Cinnamon at 1,014-1,302 ft. with a natural gage of 260,000 cu. ft., which was tubed without shooting.

Sandyville reported 12 locations for the week, Cambridge 6, Ashland and Stewart 5 each, Brush Creek 4, Lancaster 3, and Mt. Vernon 1. Thirty-three wells were completed with Stewart and Mt. Vernon leading with six each.

OHIO SUCCESSFUL WILDCAT

Coshocton County, Bedford Township: Benedum-Trees 1 J. W. Lee, Sec. 16, Clinton 3,350-92 ft., 694,000 cu. ft., TD 3,396 ft.

WESTERN KENTUCKY

OWENSBORO.—Operators in the western Kentucky area finaled eight wells during the past week, of which five were oil wells and three were dry holes. One of the latter was an unsuccessful wildcat in Henderson County. Six new operations, all development wells, were announced during the week. Three of these were located in Henderson County, and one each in Webster, Union and Ohio counties.

WESTERN KENTUCKY WILDCAT FAILURE

Henderson County: Ryan Oil 1 Griffin, 4-O-26, elev. 532 ft., dry at 2,420 ft., Waltersburg sand 1,557 ft., Glen Dean 1,693 ft., Cypress 1,966 ft., Benoist 2,123 ft., Renault 2,157 ft., Ste. Genevieve 2,211 ft., McClosky 2,271 ft.

EASTERN KENTUCKY

ASHLAND.—Setting of machinery, locations and rigging were noted on the re-

(Continued on page 359)

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—Layne Well Water Systems are known to be the best that specialized engineering research can produce—and the best that American dollars can buy. For late catalogs and illustrated literature address Layne & Bowler, Inc., General Offices, Memphis 8, Tenn.

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LAYNE

WELL WATER SYSTEMS
VERTICAL TURBINE PUMPS

More Oil Companies Announce Bonuses

SEVERAL more oil companies during the past week announced bonuses to help employes meet higher living cost. Barnsdall Oil Co. will give each employe, regardless of salary, a bonus of $25 in each of 3 months—November, December, and January.

Two extra salary payments are granted regular employes, with certain exceptions, by Phillips Petroleum Co. Those on the payroll December 1 will receive the first of these payments on that date, provided they were on the payroll November 1. The second will be made at the end of February 1947 to employes who were on the payroll January 1. In each case the payment will be a week's salary.

Stanolind Oil & Gas Co. and its officials announced a bonus to be paid in two installments, one on November 15 and the other on December 15, to employes on the payroll on those dates, each installment to be the equivalent of 10 per cent of the monthly earnings, with a maximum of $50.

Warren Petroleum Corp. granted each of its workers a bonus of $25 for each of three months—October, November, and December.

Standard Oil Co. (Indiana) announced a bonus to be paid to all employes except some relatively small groups who have received general increases since July 1. It will go to workers not represented by unions, and it was offered at the same time to the various unions representing company employes. Salaried employes and wage earners will get a week's pay with $100 as the maximum. Commission employes will receive amounts proportionate to the number of trucks they operate. All bonuses will cover the period ending January 15.

Two bonus payments, each of $50, will be made by Continental Oil Co. The first covering November and December, will be distributed on the last payday before Christmas. The second, covering January and February, will be distributed on the last payday in February.

Pantepec Leases Acreage On Gulf Coast of Florida

Approximately 4,600,000 acres, mostly along the Gulf Coast of Florida, have been leased by Pantepec Oil Co. of Venezuela, C.A. The areas are divided into 51 drilling blocks.

The cost of the Florida leases was $1,000,000, of which $250,000 remains in escrow pending the determination of the federal claim to part of the offshore tidal properties.

Consisting of three separate leases, the lessee is permitted to retain title to all of the drilling blocks for 5 years by the payment of $75,000 annual rentals. The annual rentals are at a rate of 1 cent per acre for offshore areas; 2 cents an acre for bayous, inlets and islands; and 3 cents an acre for river beds and lakes.

If the company desires to retain title to any drilling block beyond the 5-year period, an extension of the lease period for another 5 years may be obtained by spudding a well on the desired block prior to the end of the initial 5-year period. The wells are to be projected to at least 6,000 ft. The company is under obligation to drill one well which must be commenced prior to February 1, 1947, and drilled to at least 10,000 ft. unless commercial production is found at a shallower depth. The state of Florida is to get one-eighth royalty, and one twenty-fourth goes to former stockholders of Arnold Oil Explorations, Inc.

CALENDAR

November

American Welding Society, annual meeting, Atlantic City, N. J., November 18-22.

American Society for Metals, annual meeting, and National Metal Exposition, Atlantic City, N. J., November 18-22.

American Institute of Mining and Metallurgical Engineers, iron and steel division, and institute of metals division, annual fall meeting, Atlantic City, N. J., November 18-22.

Mid-Southeastern Gas Association, Raleigh, N. C., November 21-22.

Rocky Mountain Oil and Gas Association, annual meeting, Shirley-Savoy Hotel, Denver, November 21-23.

Independent Natural Gas Association of America, annual meeting, Blackstone Hotel, Fort Worth, November 22.

December

American Society of Mechanical Engineers, New York, December 2-6.

New Mexico Oil and Gas Association, annual membership meeting, Artesia, N. M., December 4.

Houston Nomads, Old College Inn, Houston, December 9.

Interstate Oil Compact Commission, winter quarterly meeting, Dallas, December 9-11.

Petroleum division, National Association of Credit Men, annual conference, Congress Hotel, Chicago, December 9-11.

Oil Dealers Association of Arkansas, Hotel Marion, Little Rock, December 10.

Los Angeles Nomads, Mayfair Hotel, December 11.

American Chemical Society, meeting of Texas sections, Dallas, December 12-13.

Mid-Continent Oil and Gas Association, annual ad valorem tax forum, Plaza Hotel, San Antonio, Tex., December 16-18.

American Institute of Mining and Metallurgical Engineers, technical meeting sponsored by the five Texas sections, University of Texas, Austin, December 18-19.

1947

January

Society of Automotive Engineers, annual meeting and engineering display, Book-Cadillac Hotel, Detroit, January 6-10.

March

American Institute of Mining and Metallurgical Engineers, annual meeting, and World Conference on Mineral Resources, Waldorf Astoria Hotel, week of March 17.

Western Metal Congress and Exposition, Oakland, Calif., March 22-27, 1947.

Oil Heat Institute of America, annual convention, Traymore Hotel, Atlantic City, N. J., March 24-30.

April

National Association of Corrosion Engineers, annual convention, Palmer House, Chicago, April 7-10, 1947.

Southern Gas Association, Biloxi, Miss., April 16-18.

Division of Production, American Petroleum Institute, Eastern District spring meeting, Pittsburgh, April 16-18.

Natural Gas Department, American Gas Association, spring meeting, Stevens Hotel, Chicago, April 30-May 2.

May

Division of Production, American Petroleum Institute, Mid-Continent District spring meeting, Amarillo, Tex., May 22-23.

Division of Production, American Petroleum Institute, Pacific Coast District spring meeting, Los Angeles, May 15-16.

June

Canadian Gas Association, General Brock Hotel, Niagara Falls, N. Y., June 16-18.

LEGAL

U. S. DEPARTMENT OF THE INTERIOR, Bureau of Land Management, Washington 25, D. C. Notice is hereby given that sealed bids will be received until 1 P.M. Wednesday, December 4, 1946, for land described herein situated within the known geologic structure of the Powder Wash field, Colorado. This land is offered to qualified bidders of the highest cash amounts per acre as a bonus for the privilege of leasing the land under section 17 of the leasing act of February 25, 1920 (41 Stat. 437, 30 U.S.C. sec. 181), as amended, in the following parcels, all in T. 11 N., R. 97 W., 6th P.M.; Parcel No. 1, sec. 7, lot 5, NE¼, NE¼NW¼, 234.24 acres. Parcel No. 2, sec. 8, NW¼, N½SW¼, 240 acres. Parcel No. 3, sec. 8, S½NE¼, SE¼, 240 acres. Total 714.24 acres. Royalties payable to the United States will be at the rate of 12½ per cent to 25 per cent for oil and 12½ per cent to 16⅔ per cent for gas, in accordance with the schedule shown on lease form. These lands lie within the approved area of the Powder Wash unit agreement, and in accordance with 43 CFR 192.29, any successful bidder will be required to file prior to the issuance of a lease, evidence that he has entered into an agreement with the unit operator for the development and operation of the lands in the proposed lease under and pursuant to the terms and provisions of the approved unit agreement, or an affidavit giving satisfactory reasons for failure to enter into such agreement. Bids must be submitted on each parcel separately, but if two parcels are awarded to the same bidder, they may be included in a single lease. Each bidder must submit with the bid one-fifth of the amount bid in cash or by certified check made payable to the order of the Treasurer of the United States, and file the showing of qualifications to receive a lease, required under 43 CFR 192.19. The envelopes should be plainly marked "Bid for Parcel No. , Powder Wash field. Not to be opened before December 4, 1946." No bids received after the hour fixed herein for receiving bids will be considered. The remainder of the bonus and the annual rental at the rate of $1 per acre must be paid and a $5,000 coroprate surety bond must be furnished by a successful bidder prior to the issuance of a lease. The deposits of the other bidders will be returned upon acceptance of the successful bids. The successful bidder will be required to agree not to discriminate against any employee or applicant for employment because of race, creed, color, or national origin, and require an identical provision to be included in all subcontracts. Bidders are warned against violation of section 59, U. S. Criminal Code, approved March 4, 1909, prohibiting unlawful combination or intimidation of bidders. The right is reserved to reject any and all bids. Fred W. Johnson, Acting Director.

Refiners Looking at "Tricks of Trade" To Aid in Solving Postwar Problems

CHICAGO. — Technological presentations before the American Petroleum Institute's division of refining meeting here this week reflected the directions of advance in refining chemistry and technology which characterize especially the postwar refining situation. Faced by the early necessity of increasing the octane rating of motor gasolines, which is expected to start actually when sufficient tetraethyl lead becomes available for the refiner to raise his octane level, now frozen at values lower than is considered "normal" for postwar products, the refiner is looking at the tricks of the trade to help himself.

Examining these methods for improving octane ratings when the inevitable really gets under way, refiners discussed means for boosting antiknock other than by catalytic cracking. A team of three papers on the application of the polyforming process to improvement of properties and yields of motor fuel carried the torch for the noncatalytic field. These papers in full or in slightly condensed form are found elsewhere in this issue. Introduction of the lighter hydrocarbons into reforming stills with naphthas results in improving the octane rating of the fuels and in producing higher over-all yields, P. Ostergaard and collaborators from Gulf Oil Corp. showed.

The demands made by new methods of hydrocarbon analysis have accentuated the need for precise methods of analysis, and for ultra-efficient fractionating columns for the exact concentration of components of light-oil fractions, it was brought out in the 10-paper symposium on analytical distillation, sponsored by the committee on analytical research. Of the several outstanding columns discussed, a 12-ft. Stedman packed column in two sections 3 in. in diameter, of stainless steel, was shown to be efficient for the study of crudes and their fractions for the isolation of individual hydrocarbons, for segregation of aviation and other gasoline components. Three years of use showed that the packing had deteriorated in efficiency from the equivalent of 80 theoretical plates to 40 plates; this still can be used at pressure up to 100 psig.

Greater Profits Seen for Distillate Fuels

CHICAGO.—Refiners attending the A.P.I. meeting were told that aside from a few exceptional cases, it will never again be necessary to price distillate fuels on a less profitable basis than gasoline. Robert Gray, of Fuel-oil and Oil Heat, who made this prediction, said further that although up until recently, distillate fuel had been less profitable to the refiner than gasoline throughout the history of oil heating, this was due to its competition with coal when coal was cheap. Coal, Gray said, is no longer a competitor and oil heating, having won that battle, no longer needs to be subsidized.

With recognition that this change in pricing is permanent, the speaker told refiners they need never again consider it necessary to limit distillate fuel output to meet gasoline demand, since they could profitably enlarge their refining capacity, even when the only need comes from rising distillate-fuel volume. Refiners, he predicted, will find themselves planning and developing more effective marketing methods for fuel oil, because they will know they are dealing with a primary-profit product.

Quoting from the A.P.I. booklet, Petroleum Facts and Figures, Gray said that in the 5-year period ending in 1940, gasoline sales increased only 7 per cent per year, while distillate fuel sales increased 17 per cent a year. Thus while its present day volume is only one-third that of gasoline, the rate of increase is much faster. For the postwar era, he pointed out that an oil burner consumes three times as many gallons as an automobile, and that public opinion surveys showed that 44 per cent of the people preferred to heat with oil, as against 33 per cent who preferred gas, 18 per cent who preferred coal, and 5 per cent for electricity or wood.

John R. Sherwood, of Sherwood Bros., Inc., gave some comparisons of oil and gas heating costs in Baltimore. He cited average figures for a heating unit only, which worked out at $166.67 per year for gas compared to $144.10 for oil heat. However, there oil's advantages cease, gas having the advantage of less noise, less dirt, automatic delivery, and no servicing calls or contract arrangements necessary. In the new-building field, considering oil versus gas for combination heating and winter air-conditioning units, gas units had an advantage of $75 to $100 in installation cost. He contended that oil could still compete with gas, but that it must be backed up with absolutely reliable service both as to equipment and oil delivery.

Transportation

Transportation of petroleum by for-hire motor carriers was discussed by S. F. Niness, of Leaman Transportation Co., who pointed out that petroleum transport trucks before the war handled 25 million gallons daily, expanded to 128 million gallons daily during the war, and after a 7 to 10 per cent decrease in the early part of 1946, by now are back up to their wartime volume and expect to exceed it during this winter.

Expansion of pipe lines and new stub lines have always resulted in an expansion of truck transportation, instead of the contrary. The final link of transportation from refinery, barge, tanker, or pipe-line terminal is the tank truck. Furthermore, development of new, heretofore unknown refinery products, requiring special handling, opens new opportunities for truckers.

The speaker cited advantages the for-hire carriers have over company-owned truck transport, as: (a) Two-way or back hauls; (b) more economical where the company has work for only one half a truck; (c) eliminates labor troubles for companies in these days of shortages of good mechanics, drivers, and dispatchers. There were also, he said, vast opportunities for the for-hire carriers in the field of local and service-station deliveries. In the final analysis, all other items of delivery satisfied, the oil company's decision as to method of using trucks is decided on cost, and the for-hire carriers believe they will always have an advantage here.

Fayette B. Dow, of the A.P.I. Washington office, discussed the forthcoming Congressional Committee inquiry into our postwar national transportation policy. Pointing out that under the chairmanship of Congressman Lea, the industry could count on its being a fair inquiry and not an investigation, the speaker discussed some of the points of view that would be presented and urged by various other transportation agencies. In another paper, Donald D. Conn of the Transportation Association of America, Chicago, discussed the activities of that organization during the past 12 years.

The outlook for tax revision and various alternatives in the size of the national government budget and what they would mean in terms of tax reduction was discussed by Harley L. Lutz, of Princeton University.

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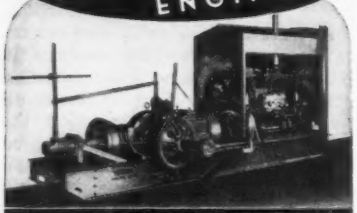

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Among the Drilling Contractors

Atlantic Oil Co., Long Beach, will redrill Del Amo Estate Co. 26 fee in the Torrance field, Los Angeles County.

Thorne Drilling Co. of Henderson, Ky., has contract to drill the A. S. Mims 1 James Y. Welborn, SE NW 18-7s-11w, Vanderburgh County, Indiana. The test is located on the southwestern edge of the Heusler field.

Rhine Drilling Co. has been awarded contract to drill the 1 Brock, SW NW SE 7-23-11w, Stafford County, Kansas, for Lion Chemical Co. The test is on a block of 240 acres held by Lion and is a prospective extension to the Brock pool.

Schlumberger Oil Surveys of Los Angeles are planning to open branches at Calgary and Lloydminster as soon as accommodations can be arranged. Andray Perri, Calgary manager, recently flew to Los Angeles in connection with the arrangements.

Charles Mills, drilling contractor, of Lloydminster, Sask., is securing an airplane to connect his operations in that field, where he has four strings of tools operating, with outside points.

Meredith, Clegg & Hunt, of Houston, have contract to drill 2 Miller for Warren Petroleum Co. in the Altair field, Colorado County, Texas. Contract depth is 10,500 ft.

K. L. Kellogg & Sons, Long Beach, have the contract to deepen General Petroleum Corp. 31 Long Beach Harbor, in the Wilmington field, Los Angeles County, California.

I. W. Murfin will drill a new exploratory test in Marion County, Kansas, for S. & S. Oil Co. et al. The venture will be the 1 Stallwitz, NW NE SE 2-20-4e, 3 miles east of Marion and 8 miles north of the Florence pool.

Byron Meredith, M. F. Clegg, and Lloyd M. Hunt have announced purchase of the S. W. Morris interest in **Morris & Meredith, Inc.** (a Texas corporation) drilling contractors of Houston, together with the acquisition of the assets of **Clegg Drilling Co.** of Corpus Christi. The firm's name will be changed to **Meredith, Clegg & Hunt.** Officers of the new company will be Byron Meredith, president; M. F. Clegg, vice president, and Lloyd M. Hunt secretary and treasurer. The company is operating five large rotary-drilling rigs in the Gulf Coast area of Texas and Louisiana and in Southwest Texas, and will maintain offices at 1527 Niels Esperson Building, Houston.

Wallace Slusser is the contractor for the Dwight Wilson 1 Holub, NW NW SE 5-19-4e, a wildcat test located 4 miles north of the town of Marion, in Marion County, Kansas.

Dowell, Inc., Calgary branch, has put in service an airplane, flown by Roy Graves, to link field operations with its Calgary headquarters.

Norman & Graham have received contract to drill the 1 Bennett in NE SW 30-3s-13w, Cotton County, Oklahoma, for Paul W. Fleeger of Wichita. Contractors have an interest in the test, which is also being supported by Harry Gore of Wichita through the purchase of acreage.

Texola Drilling Co. has staked location for a test 1¾ miles south of Boley in Okfuskee County, Oklahoma. The venture is the 1 Replogle, SW

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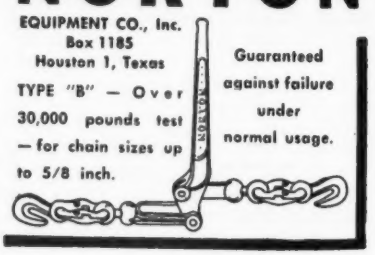

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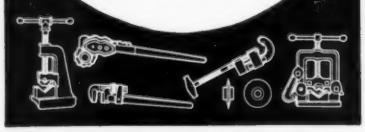

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Hobbs, N. M.	275-R

NW SE 33-12n-8e, about 1½ miles west of production in the Dill field with a dry hole interventing.

Camay Drilling Co., Los Angeles, has spudded Southern California Petroleum Corp., Ltd., 103 Aguirre, Section 13-4n-18w, Ventura County, California.

George & Wrather Drilling Co. of Mt. Carmel, Ill., has received contracts to drill two wells in the New Harmony-Griffin field of Indiana for George S. Engle. The tests will be the 2 John Swonder, NE SE 34-3s-14w, and the 3 John Swonder, NE SE 34-3s-14w.

Graham & Schneider of Salem, Ill., will drill the 1 Baker, NW SE NE 8-7s-14w, Posey County, Indiana, on contract for H. C. Detrick of Evansville, Ind. The venture is a wildcat test 2 miles west of the Prairie pool and about the same distance north of the New Haven field.

Seventy-Fifth Anniversary of Bradford Field Celebrated

BRADFORD, Pa. — The seventy-fifth anniversary of the Bradford oil field will be the occasion for a 3-day celebration November 18-20. A feature will be unveiling of a plaque paying tribute to Job Moses, who in 1871 drilled 1,100 ft. to start production from the Bradford sand. Crude from the field commands $3.41 a barrel, which is $1.81 above the country's average.

The field's biggest output for one day was 50,200 bbl., recorded in 1937, and the average daily production for that year was 46,000 bbl. Since then the yield has been dropping. Pennsylvania oil men say that by 1950 production will be down to 18,500 bbl. a day. Five years later, they say, daily production will not exceed 10,000 bbl.

Bradford owes its continued productivity to the development of water-fooding, a technique pioneered in this area. In the 20 years that this method has been used here, oil producers have gotten out as much crude as in the first 50 years of the field's history.

New Substation Opened

WICHITA FALLS, Tex.—The United States Bureau of Mines will open substation offices in the Federal Building here next week in a move which officials of the North Texas Oil and Gas Association expect to stimulate the program of secondary oil recovery in this area. D. B. Taliaferro, of Bartlesville, Okla., and R. K. Guthrie, of Dallas, both petroleum engineers, will be temporarily assigned to the office here and a permanent staff will be provided later.

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PERSONALS

New Division Head Has Seen Much Of the World

GEORGE M. CUNNINGHAM, manager of the new exploration department organized by Standard Oil Co. of California, has seen much of the world since he went to work for that company following his graduation from University of California in 1921 with a B.S. in civil engineering. Before that he had served 2 years in the Twenty-ninth Engineers, A.E.F., at the front and as an instructor in sonic range-finding. He also had worked as an oil-field roustabout and for U. S. Geological Survey and Forest Service.

Following his first job with Standard, in the San Joaquin Valley, where he did topographical mapping, he was sent to Utah and Montana on exploration tours. Returning to California, he spent the next several years in exploration and map making and then, in 1927, became district geologist for the San Joaquin Valley. He played an important part in the initial development of Kettleman Hills.

In 1933, Cunningham took Standard's first seismographic survey crew to Mexico. The party located the Cuichapa field by the new method.

The following year, as senior geologist, Cunningham organized a staff of geologists to supervise geophysical activities for the parent company and its subsidiaries and affiliates. In California this work resulted in discovery of the Greeley oil field and the Semi-Tropic, Trico, McDonald Island, and Vernalis natural-gas fields.

Cunningham was closely identified with work in the Rocky Mountains, the Gulf Coast, and Canada, and he played a part in geophysical tests in Venezuela, Colombia, Saudi Arabia, Egypt, India, and Netherlands East Indies. He was named assistant chief geologist in 1937 and chief geologist in 1943. He became general manager of exploration for the producing department in 1944.

W. W. Bruce, executive vice president of Continental Oil Co., has retired after 18 years' service. Before joining Marland Oil Co., predecessor of Continental, in 1929, he was vice president of sales for The Texas Co.

R. R. Robinson, production manager in Los Angeles for Shell Oil Co., Inc., who went to Alberta a year ago to assist in solving problems in connection with the company's Jumping Pound drilling, has returned to Los Angeles. While in Alberta he was appointed a member of the Alberta Petroleum Association's advisory committee to the Natural Gas and Petroleum Conservation Board.

O. C. Nonweiler has been appointed general superintendent of Ajax Pipe Line Corp., with headquarters in Springfield, Mo. Formerly with Interstate Oil Pipe Line Co., Nonweiler has been acting superintendent of the Ajax system since July 1943. Prior to that time, he was chief engineer of the Interstate company in Tulsa.

Ivan G. Burrell, Bridgeport, Ill., has been appointed to the engineering committee of the Interstate Oil Compact Commission. Other Illinois men recently appointed to commission committees include: **E. J. Coyle,** Springfield, legal and **Dr. A. H. Bell,** Urbana, research and coordinating. **Samuel F. Peterson,** Springfield, was reappointed to the regulatory practices committee.

George P. Livermore, Lubbock, Tex., drilling contractor and independent operator, has been named chairman of a committee to assist in expanding petroleum-engineering education at Texas Technological College, Lubbock. Also appointed to the committee were **Wallace E. Pratt,** Frijole, N. M., geologist; **Owen Thornton,** The Texas Co., Houston; **Max K. Watson,** assistant to the president of the Canadian River Gas Co., Amarillo, and **H. E. Chiles,** president of Western Co., Seagraves.

O. J. HAYNES

O. J. Haynes, formerly superintendent of exploration in the southern division, producing department, for Standard Oil Co. of California, with his office in Los Angeles, has been made assistant general manager of a new exploration department organized by the company. He has been in the company's service since 1923. **George M. Cunningham,** whose oil career is presented on this page, heads the new department. Appointments to new posts in the department include **W. P. Winham,** superintendent southern district; **G. L. Knox,** superintendent northern district; **A. J. Solari,** superintendent Bay district, and **W. F. Barbat,** assistant chief geologist. Exploration department staff members who will continue with their former titles are **W. S. W. Key,** chief geologist; **S. H. Gester,** assistant chief geologist; **G. C. Gester,** consulting geologist; **Phil Gaby,** consulting geophysicist; **G. F. Schroeder,** manager land and lease division, and **L. H. Hines,** assistant manager land and lease division.

F. I. L. Lawrence, director of research and development of Kendall Refining Co., has been appointed a member of the committee on analytical research of the American Petroleum Institute.

D. J. Hanna, vice president of California Texas Oil Co., Ltd., left the United States early in November for a business trip to Caltex properties in the Middle East and expects to return shortly before Christmas.

Fred A. Shellhorn, formerly traffic manager of Hanlon-Buchanan Co., has been appointed traffic manager of Anchor Petroleum Co.

Roland Whealy has been named general refinery superintendent of Ashland Oil & Refining Co.'s No. 1 plant at Ashland, Ky., succeeding **E. A. Brown,** who resigned in September. Whealy had been acting general superintendent. Previously he had served as superintendent of the laboratory and of the blending and treating department.

Alec M. Crowell, of Jackson, Miss., director of the Mississippi Oil and Gas Engineering Committee, has been granted leave of absence to join the staff of the Department of Interior's Oil and Gas Division as director of its conservation and reserves unit. He will assume his new duties about December 1. **John K. Wright, Jr.,** chief engineer with the committee, will serve as acting director in Crowell's absence.

F. G. Keefe, manager of United Overseas Petroleum Co., Ltd., has returned to the London headquarters after a vacation in the United States. United Overseas is the recently organized service company jointly owned by Standard Oil Co. of California and The Texas Co.

W. M. Vaughey, Jackson, Miss., independent operator, was named president of the Mississippi-Alabama division of the Mid-Continent Oil and Gas Association, and **A. R. Carmody** was chosen president of the association's Louisiana - Arkansas division, in elections at division membership meetings last week. **E. D. Kenna,** Jackson, was reelected executive vice president of the Mississippi-Alabama division and **J. P. Evans, Jr.,** Jackson independent operator, first vice president. Regional vice presidents include: **Dennis Granberry,** Laurel, Miss.; **Robert Genin,** Bay St. Louis, Miss.; **Birney Imes,** Columbus, Miss.; and **James L. Duffy,** Grove Hill, Ala. Others elected in the Arkansas-Louisiana division include **Sam S. Caldwell,** executive vice president and secretary, who will assume his duties November 16 upon termination of his term as mayor of Shreveport. New directors are **George Wilson,** Interstate Natural Gas Co., Inc., Baton Rouge; **E. G. Robinson,** Shell Oil Co., Inc.; **W. F. Dalton,** Hunt Oil Co., and **Henry Walker,** Arkansas Louisiana Gas Co. Vice presidents named are **J. J. Fromoter,** Ohio Oil Co.; **J. T. Goodman,** Gulf Oil Corp.; **C. H. Lyons,** Lyons & Prentiss; **A. H. Tarver,** independent operator, and **A. H. Weyland,** Arkansas Louisiana Gas Co.

B. C. Brown, construction foreman in West Texas for Shell Oil Co., Inc., has been promoted to engineer's assistant at Odessa, Tex., and **G. H. Barnes,** chief clerk of the East Texas division, has been named production foreman at Kilgore. **C. J. Ward,** senior exploitation engineer, has been transferred from New York to Houston. Other transfers of Shell personnel in the Texas-Gulf area include: **G. P. Atkinson,** junior engineer, Sheridan, Tex., to Magnolia, Tex.; **R. Porter,** junior engineer, Magnolia to Sheridan; and **H. C. Schnieder,** chief accountant, Houston refinery, to the exploration and production research department.

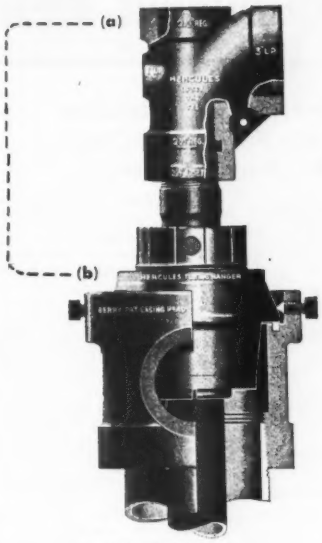
Shifts

John L. Smith, engineer, C. F. Braun & Co., Baldwin Park, Calif., to Covina, Calif.; **Wm. H. Hudson,** foreman, Standard Oil Co. of California, El Cerrito, Calif., to Berkeley, Calif.; **Richard H. Smith,** engineer, Southwest Exploration Co., Huntington Beach, Calif., to South Pasadena, Calif.; **O. F. Sebesta,** engineer, The Texas Co., Ft. Stockton, Tex., to Crane, Tex..

A. L. Cunningham, engineer, Magnolia Pipe Line Co., Washam, Tex., to Panola, Tex.; **Paschal Martin,** engineer, Pure Oil Co., Houston to Chicago; **J. K. Ellis,** superintendent, Transwestern Oil Co., San Antonio to Tulsa; **J. Paul Ratliff, Jr.,** engineer, Humble Oil & Refining Co., Coushaffa, La., to Crowley, La.; **Thomas M. Moore,** engineer, Standard Oil Co. of Indiana, Chicago to Calumet City, Ill.

A. V. Hedges, superintendent, Shell Oil Co., Inc., Toledo, Ohio, to Lima, Ohio; **A. W. Black,** foreman, Continental Oil Co., Walden, Colo., to Cheyenne Wells, Colo.; **V. D. Miller,** superintendent, Noble Drilling Corp., Buxton, N. C., to Ocean City, Md.; **H. B. Hite,** superintendent, Amerada Petroleum Corp., Cyril, Okla., to Duncan, Okla.; **Ray G. Chapman,** engineer, Chapman Oil Co. of Texas, Kaw, Okla., to Cisco, Tex.

Harry C. Weiss, president of Humble Oil & Refining Co., headed a party of officials on a recent visit to Humble's Midland, Tex., office and the Permian basin area. Humble oil officials in the party included: **Hines H. Baker,** executive vice president; **David Frame,** vice president and director in charge of production; **Morgan J. Davis,** manager of the exploration department; and **Carl J. Reistle, Jr.,** general manager of the production department. Executives of Standard Oil Co. (N. J.) making the trip included: **R. T. Haslam,** director in charge of public relations; **George H. Freyermuth,** manager of the public relations department; **Howard W. Page,** head of the legal department; **W. E. Hoagland,** head of the economics department; **W. R. Finney,** head of pipe-line operations; and **B. B. Howard,** director of transportation. Midland representatives of Humble who accompanied the visitors included: **John W. House,** division superintendent; **J. P. Ruckman,** assistant division superintendent; **R. S. Dewey,** division petroleum engineer; **J. W. Graybeal,** associate division petroleum engineer; and **V. C. Maley,** division geologist.



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Note how the Hanger sits down in the casing head out of the way; the compactness of the entire hook-up . . . reducing the number of connections necessary in connecting a well the old way.

(a) Hercules Pumping and Flowing Tee is the original and only Tee with a combination Plain and EUE thread. (Supplied in any combination.) Heavier and stronger than an ordinary Tee.

(b) Hercules Forged Steel Tubing Hanger—with Forged Steel Slips on which tubing hangs—affords absolute tubing protection. Has the FAMOUS Hercules Packing above slips with threaded nut to distort packing, independent of tubing weight. (Fits any Berry Pattern Casing Head.)

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Equipment Men in the News

American Iron & Machine Works Promotes McCool, Adds Rental Division

M. G. McCOOL

M. G. McCool has been appointed vice president in charge of sales and manufacturing and a member of the board of directors of American Iron & Machine Works Co., Oklahoma City. McCool joined the firm in 1935 and functioned as district manager in West Texas until 1940 when he became secretary and general sales manager at Oklahoma City. J. A. Gray, president of the company, announces that the former Gray Supply Co. will be operated as the Gray Rental Division of American Iron & Machine Works Co. The Gray Rental Division has Gulf Coast headquarters at 1801 Semmes Street, Houston, and is managed by C. D. Fitch, assisted by C. L. Braswell. The division has branches at Shreveport and Harvey, La., and Houston, Alice, and Odessa, Tex.

Oil Well Supply Makes Personnel Changes

Personnel appointments in the sales department have been announced by Oil Well Supply Co. Named assistant general managers of sales were F. D. Smith and M. F. Hazel. Named sales department managers were V. J. Waters, drilling equipment; J. S. Fuller, production equipment; C. A. Bell, used equipment, and M. D. Routzon, merchandise claims. Each of the six officials named has been located in the general offices and will continue to headquarter in Dallas.

Lilley New District Manager of Timken

H. B. Lilley has recently been appointed district manager of the Timken Steel and Tube Division with headquarters in Houston, according to an announcement made by officials of The Timken Roller Bearing Co., Canton, Ohio. His territory will include Texas, Louisiana, Arkansas, Oklahoma, and Kansas.

Thompson Sales Manager For Climax

R. G. "Tommy" Thompson has been appointed by Climax Industries, Inc., as sales manager of the L.P.G. division, Tulsa. Thompson has been associated with the Skelgas division of Skelly Oil Co. since 1941 as a special representative. Previously he had traveled the Southwest for Butane Equipment Co.

Willis Oil Tool Co.

Transamerican Factors, Ltd., will represent Willis Oil Tool Co., Long Beach, Calif., in Colombia, Venezuela, Ecuador, and Peru, South America. The name of the above company should have been included in the listings of California manufacturers which appeared on page 173 of the October 26 issue of The Oil and Gas Journal.

Gardner-Denver Appoints Leece General Sales Manager

G. V. Leece, vice president of Gardner-Denver Co., has been appointed general sales manager for the company. Leece joined Gardner-Denver in 1922 and for the past 2 years he has been vice president in charge of the export division with offices in New York City. For 5 years previous to this appointment, he was district manager of the New York branch office and for 7 years prior to that Pacific Coast manager.

Clemens in South America For Martin-Decker

John A. "Jack" Clemens, Martin-Decker Corp., sales engineer, is on a 6-month trip to South America for the purpose of assisting customers in the use of company products. Clemens' itinerary will include Trinidad, Colombia, Peru, Chile, Argentina, Brazil, and Mexico. On his return to this country, he will again direct operations in the Gulf Coast and Mid-Continent from his Houston headquarters.

Pilots for oil companies operating in Venezuela frequently brush wings over the jungles of South America but they rarely meet on the ground for a "hangar-flying" session. Exception was a recent surprise reunion when they parked their planes simultaneously at Southwest Airmotive Co., Dallas. Shown as they studied a map of the courses they'll follow when they return to Venezuela are: Box Morgan of Dallas, Mene Grande Oil Co.; Dave Kennedy of Canada, Caribbean Petroleum Co.; Gordon Silva of New York, Mene Grande's director of aviation, and Paul W. Hardy of Los Angeles, Caribbean Petroleum Co.

New Dowell Plant Displayed to Industry

The new Dowell plant facilities at Tulsa were the scene of an "open house" visitation and inspection by a large group of oil men and engineers in the Mid-Continent area on November 6. Groups were taken through the newly constructed research laboratory, plastic-manufacturing plant, assembly shops, and warehouses. On exhibit were new acidizing units, including portable compressors for treating gas wells, electric pilots, and special trucks for applying plastics to wells by bailer methods. Present as hosts for the event, which included a buffet dinner, were: John G. Staudt, vice president and general manager; R. D. Shaw, general sales manager; Marshall Stirling, sales manager oil and gas-well division; H. W. Ross, sales manager industrial sales division; Dana G. Hefley, chief research engineer; G. N. Thresher, chief engineer; Paul Cardwell, chief chemist; Harold Staadt, manager plastics manufacturing plant, and Paul Fitzgerald, geologist.

Sharpe and Brown Promoted in Gar Wood

Clifford A. Sharpe has been elected vice president in charge of manufacturing of Gar Wood Industries, Inc. J. E. Brown has been appointed manager of the Philadelphia branch, Kensington and Sedgley Avenues, in charge of the products of the hoist and body, winch and crane, and tank divisions.

Waukesha Opens New Sales Office

Waukesha Sales & Service, Inc., has recently opened a sales office at 529 Waggoner Building, Wichita Falls. S. W. Wacey has been transferred from the Dallas office and has been made district manager of the North Texas district, with headquarters in Wichita Falls.

Ideco Appoints Mid-Continent Sales Manager

O. M. Havekotte, president of International Derrick & Equipment Co., has announced appointment of C. A. McClelland as manager, Mid-Continent direct sales. McClelland will maintain headquarters at the central sales office in Dallas.

Hurlbutt and Herring Form New Exploration Company

Ben Hurlbutt and Frank Herring have established Ben Franklin Exploration, Inc., which will specialize in core-drill exploration. Offices of the company will be at 805 Petroleum Building, Wichita.

Turner Named Assistant Sales Manager of La Plant-Choate

K. V. (Ken) Turner has been appointed assistant sales manager of La Plant-Choate Manufacturing Co., Inc., Cedar Rapids, Iowa. Turner started work for La Plant-Choate as a blueprint clerk in the engineering department in 1938. Since then his experience with the company has been diversified, including service work, export sales, government cales, field-engineering research, district sales representative in northeastern United States, and coordination between the federal Government, sales and production.

Core Laboratories Completes Removal Program

James A. Lewis, president, Core Laboratories, Inc., has announced that removal of the research laboratory and general

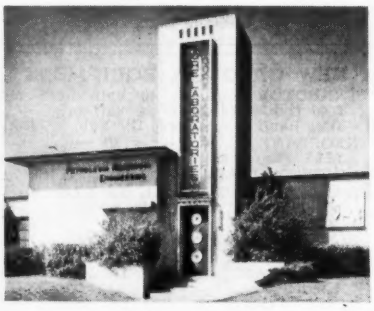
JAMES A. LEWIS

W. H. DAVISON

J. H. CAMPBELL

J. R. PHILLIPS, JR.

office facilities and personnel has been completed at the organization's new location at 2151 Fort Worth Avenue, Dallas. Also, the North Texas division and the reservoir fluid analysis laboratory, both formerly located with the general offices in the Highland Park shopping village, have been established at 6923 Snider Plaza. General offices in Dallas are under the supervision of Lewis; W. H. Davison, assistant to the president; J. H. Campbell, vice president; and J. R. Phillips, Jr., assistant secretary and treasurer.



New location of Core Laboratories, Inc., general offices

Bovaird Opens Store at Pauls Valley

Bovaird Supply Co. announces the establishment of a new store at Pauls Valley, Okla. The store will be under direction of District Manager V. P. McAnally of Oklahoma City.

Brown Elected Director

H. S. Brown, chairman of the board and president of Foster Wheeler Corp., has been elected a director of Liberty Mutual Insurance Co.

Pittsburgh Lectrodryer Adds Gooch

D. B. Gooch, of Birmingham, has recently been appointed sales representative of Pittsburgh Lectrodryer Corp., Pittsburgh. Gooch will represent the company in North and South Carolina and parts of Alabama and Georgia.

Boll and Palmer New Managers for U. S. Rubber

Establishment of a Detroit sales division and appointment of two division managers are announced by W. D. Baldwin, sales manager of the U. S. Tires division of the United States Rubber Co. John A. Boll was named manager of the newly formed Detroit division. Boll's headquarters will be at his company's Detroit branch. William J. Palmer was appointed divisional manager for the eastern division, with headquarters in New York.

Everett New Continental Supply Store Manager in Wichita Falls

Continental Supply Co. has announced appointment of W. R. Everett, Jr., as store manager of its Wichita Falls, Tex., branch. Everett succeeds H. H. Waters, who has resigned.

Gow General Sales Manager Of Leland Equipment

Robert T. Gow has been appointed general sales manager of Leland Equipment Co., Tulsa, it is announced by Harold R. Downs, president.

Bond Designated Votator Sales Manager

ALLEN M. BOND

Appointment of Allen McKee Bond, Jr., as sales manager of Votator's fats and oils section was recently announced by John E. Slaughter, Jr., vice president of The Girdler Corp., Louisville, in charge of the firm's Votator division. Bond was formerly research director of Brown & Williamson Tobacco Corp.

Stirling Joins Elliott

Norman W. Stirling has joined the New York office organization of Elliott Co., Jeannette, Pa. Elliott was president of the Heat Exchange Institute for a 1-year term and president for 3 years of the Tubular Exchanger Manufacturers Association, of which he was also one of the organizers.

Kemp Advances Kohut

Announcement is made by The C. M. Kemp Manufacturing Co. of Baltimore of the advancement of Frank J. Kohut to the over-all post of general manager. Formerly sales manager and chief of development, Kohut will now supervise production and engineering.

Davis Forms New Company

W. A. (Red) Davis announces his resignation as sales manager for LeBus Rotary Tool Works. Davis will form his own company at 2375 Bolsover, Houston, and will handle sales and distribution of oil-field specialties. He will continue to represent LeBus Rotary Tool Works as agent for the oil-field division.

Clevenger Joins Southern Gas & Equipment

Keith Clevenger has joined Southern Gas & Equipment Co., Tulsa, in the capacity of sales promotion and advertising manager. Clevenger had been associate publisher of Natural Gas magazine. For a number of years he was public-relations director of advertising and publicity for American Gas Association, New York.

Franklin New Representative for Harvey Emergency Radio

Robert E. Franklin was recently designated distributor for Harvey Emergency Radio Equipment Co., Houston. Franklin opened offices at 625 M & M Building, Houston, and will serve Texas, Oklahoma, New Mexico, Arkansas, Louisiana, Mississippi, and Alabama.

Jazwinski Joins Barium Steel

S. J. Jazwinski has been appointed chief metallurgist of Barium Steel Corp., New York. Jazwinski will handle customer relations, technological research and improvement, and expansion of production facilities.

Neely Goes to Mexico

Steele S. Neely, of the Acid Engineering Co., Tulsa, left October 10 for Mexico City for a visit with oil officials there.

OWEN

TYPE "B" WORK BENCHES

SMALL AND INEXPENSIVE BUT THERE'S PLENTY OF WORK AND STORAGE ROOM

THERE'S lots of storage space in the four big roller-mounted drawers and swing-out rag bin in the Owen Type "B" Bench. The 5' x 2' table, with sturdy vise stand, provides ample working space. Type "B" Benches are all-steel, all-welded and skid-mounted for strength and ease in moving.

Designed for light drilling and workover rigs and for utility use on heavy rigs, these benches protect tools and instruments against loss and damage and increase crew efficiency by providing a convenient work-spot right on the rig floor.

"MODERNIZE" YOUR RIG WITH AN OWEN WORK BENCH . . . THEY'RE AVAILABLE THROUGH SUPPLY STORES EVERYWHERE

OWEN TOOL COMPANY
ROUTE 9 BOX 800-B V-2-4341
HOUSTON, TEXAS

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THE OIL AND GAS JOURNAL
P. O. Box 1260, TULSA, OKLAHOMA

EQUIPMENT FOR SALE

FOR SALE: Diesel Engine powered rotary drilling rig, suitable for 5,000′ drilling. Priced cheap for quick sale. Phone 306. Box 1360, Seminole, Oklahoma.

FORT WORTH Model D Spudder with built-in shear poles and Climax Model R-41 120 H.P. gas-gasoline engine. Travco Equipment Co., 110 Midco Bldg., Tulsa, Okla. Phone 5-2251.

FOR SALE: 5,000′ 4½″ OD 16.60# Range 2 drill pipe with regular tool joints; 6,100′ 4½″ OD 16.60# Range 2 drill pipe with A.P.I. F.H. tool joints. Also 1 steel drilling rig complete with boilers and drill pipe capable of drilling 6,000′. 7 Nixon Gas Lifts complete with weights, lifts and line Wire, write or phone Louisiana Iron & Supply Co., Shreveport, La.

EQUIPMENT FOR SALE

FOR SALE OR RENT: 8,000′ 4½″ A.P.I. Full Hole Drill Pipe. Melton Well Service. Seminole, Oklahoma.

FOR SALE: 24 Pumping Units. All types & sizes. New and used. Bridgeports, Jensens, Americans, Atlas, M.I.W. with or without Power. Glenn Supply Co., 3600 Sand Springs Road. Phone 3-9607, Tulsa, Okla.

FOR SALE: Model 55 Wichita Spudder less mast with PA-100 International engine in good condition. Located near Pampa, Texas. Nabob Oil & Gas Company, Box 448, Amarillo, Texas.

AVAILABLE FOR IMMEDIATE DISPOSAL, five 2½ to 5 x 10 used Gaso side pot enclosed horizontal duplex power pump for pressure ranging from 600 to 1400 lbs. working pressure with a capacity 38 to 175 gallons per minute. QUAKER STATE OIL REFINING CORP. Box 337, Bradford, Penna.

VALVES—FITTINGS
STEEL AND CAST IRON
ALL SIZES AND PRESSURES
VICTORY SUPPLY COMPANY
Phone 5-2073 P.O. Box 754
Tulsa, Oklahoma

BLOWOUT PREVENTORS FOR SALE

2—10¾″-6000 Pound Test Type 38 Shaffer.
2—13⅜″-4000# Test Type 34 Shaffer.
2—13⅜″-4000# Test Type SDA Cameron.
Other Types and Pressures for sale or rent.

EARLE ADKISON
P.O. Box 814, Phone Fax 9339
Houston, Texas

EQUIPMENT FOR SALE

PULLING UNIT—1936 Franks ET 5000′ skid unit with SRK Waukesha motor mounted on 1936 C50 International truck. Ready to work. $2,000 cash. Mumy Well Service, Reed City, Mich. Phone 586.

FOR SALE: 1—18′ Durnell Band Wheel Power with 24″ Double Eccentric and 1—18′ Durnell Band Wheel Power with 18″ Double Eccentric, both with steel wheel at $150.00 each. Cities Service Oil Company, Patridge, Bartlesville, Oklahoma.

5 COMPLETE Reda Pumping Units. Cables like new, 75 and 97 H.P. Motors. Max Steinbuchel. 1905 Park Place, Wichita 4, Kansas, Phone 5-0682.

1 U M Allis-Chalmers Tractor pulling unit with 48′ mast pole—$2500.00.
1 U E Allis-Chalmers Tractor pulling unit with 48′ mast pole—$2750.00.
Write Box 97, Fox, Oklahoma.

60 HP PATTEN Brothers Engine, direct connected compressor, vacuum. Goulds water pump, scrubber and accumulator tanks, gas traps, 4000 gal. iron tank. Meter and buildings. Donald F. Baker, 131 North Xanthus, Tulsa, Oklahoma.

FOR SALE: E.L.I. Type A-3 Portable Shot-Hole Drill with either Moyno or Myers mud pump. Complete with engines, kelly, drill pipe and swivel. Rated: 250′ of 4½″ hole. Good condition. Presently trailer mounted with folding mast. Will sell with or without trailer. Reasonably priced. Location — Shreveport. Heiland Exploration Company, 630 Giddens-Lane Building, Shreveport, Louisiana.

FOR SALE
10—30′x38′, 200,000 gallon capacity steel storage tanks, built in 1942.
3—8′x40′, new propane storage tanks.
ROGERS AND WRIGHT
715 Peoples Exchange Building
P.O. Box 1572
Charleston 26, West Virginia
(Phone 30-171)

FOR SALE
100—84′ steel derricks — Muskogee Iron Works.
159,000# capacity. Complete with 2 beam —2 sheave crown blocks. Price $350 each, FOB cars, Arp, Texas.
LOUISIANA IRON & SUPPLY CO.
Longview, Texas
Phone LD21

NEW GASOLINE EQUIPMENT

TRI-ROTOR PUMPS, 40 gpm @ 2500 rpm, 1¼″ openings, variable flow hand control, #20-DV Yale	$35
NEOPRENE HOSE, 1½″ x 30 feet, M&F couplings	$17.50
LINE STRAINERS, 1½″, #187 OPW	$5.75
GASOLINE ENGINES, 1½ hp, B&S model NPR, 1.39 ball bearing speed reducer	$60
FLEXIBLE COUPLINGS, ¾″ x 2½″ OD, with disc	$3.50
LIGHT PLANTS, 1½ KW, 110/1/60, Kohler	$350
STEEL TANKS, 500 bbl., 21′6″ x 8′ high, bolted type	$750

LARGE STOCKS—QUICK SHIPMENTS
J. A. POSTELL
165 Spring St., N. W. Atlanta 3, Ga.

SPECIAL PURCHASE

NEW GASO — BYRON JACKSON — HALE PUMPS

100—**New** Gaso Fig. #1860, 900# 2½″ to 4½″ Bore x 6″ Stroke (Removable Liners 4½″ Now in Pumps) Totally enclosed Duplex Power Frame Timken Bearing Equipped Side Pot Type Fluid Cylinder, Bronze Wing Guided Valves, Stainless Steel Piston Rods, Bakelite Piston Ring Packing, with 28.8″ PD 5 Sheave Groove C Pulley, 5-144 C Belts, Heavy Sheet Iron All Weather Belt Guard, on Steel Skids. Extra with each pump—2—4½″ Liners, 2 Piston Rods, 8 Valves, 8 Valve Seats, 8 Valve Springs, 2 Bearings 1⅞″ (Hi-Speed Shaft)—2 sets Stuffing Box Rings, 28 pieces gaskets—Tools 1″ End Wrench, ⅝ and ¾ End Wrench—4—½″ to 1⅛″ Double Box Wrenches, 1″ Piston Rod Wrench, 30 degree offset, ⅝ x ⅛″ End Wrench, 2 packing hooks, valve seat puller, liner puller, Zer Grease Gun, 12″ Crescent Wrench, 18″ Ridgid, 2 Box 12 ft. Wrench, 1⅞ x 1⅛″ Socket Wrench, 1¼″ w/½″ sq. Drive Socket Wrench, 1⅝″ w/½″ Socket Wrench, 1⅝″ x ¾″ socket reducer, ¾ x ½″ Breakover handle, No. 79 outside caliper.

100—**New** Byron Jackson 3″, 900#, Two Stage PUP Centrifugal Pickup Pumps with Model C-36 Chrysler Industrial 8 Cylinder Engines, Complete with Battery, Muffler, Penn Switch, Mercoid Control, No. 23 Fire Extinguisher, Couplings for Parallel Operations, Mounted on Steel Skids with extra parts and tools. 1 Fan Belt, 8 Spark Plugs, Distributor Rotor and points, 30 ft. Copper Tubing, Grease Gun, 3# Grease, ½ Pt. Oil Can, 6″ Screw Driver, 8″ pliers, 10″ and 12″ Crescent wrenches, End Wrenches, Socket Wrenches, Ridgid Wrenches, etc.

Priced to move F.O.B. San Antonio, Texas
All Units crated for export.

50—**New** Chrysler-Hale high pressure pumping units, Hale centrifugal pumps, 500 GPM at 150 lbs. pressure, 346′ head, 4″ suction, 2—2½″ Discharge outlets, direct connected to model T118, 59 HP 6 cylinders, 2⅞ x 4½ B&J Chrysler engines—length 76½″, height 45″, width 26″, weight 1746#.—All units are new, boxed for export. Write for bulletin and price. Ideal for irrigation, fire protection water supply. Jetting, Pipe Line Service.

H. A. McCARTHY
310 Thompson Building, Tulsa, Oklahoma. Phone 5-3296.

ETHYL PLANT

One—3250 gallon lead blending plant, complete with 30 ton scales weightograph; Goulds 5x4 centrifugal pump with 20 HP G. E. motor. All housed in 30x20 steel insulated building with 10′x10′ brick wash room. Located Lewiston, Mont.

For complete information, write, call or wire

Brown-Strauss Corporation
1548 Guinotte Ave. Kansas City, Mo.
P.O. Box 78 Phone Ha 1000